BOOK OF DESIGNS

FOR

SCHOOL HOUSES,

AND

SUGGESTIONS AS TO OBTAINING PLANS,

AND

HOW TO HEAT AND VENTILATE

SCHOOL BUILDINGS.

By G. P. RANDALL, Architect.

CHICAGO:
KNIGHT & LEONARD, PRINTERS.
1884.

Below I give the reader a list of some of the prominent buildings for educational purposes designed by me, but this list only comprises a small part of what we call public school buildings that I have designed:

Northwestern University, Evanston, Ill.
Evanston College for Ladies, Evanston, Ill.
Ladies' College of Madison University, Madison, Wis.
Mercer University, Macon, Ga.
Academy of the Sacred Heart, St. Louis, Mo.
St. Mary's Academy, Leavenworth, Kas.
Jefferson Liberal Institute, Jefferson, Wis.
State Normal University, Normal, Ill.
State Normal School, Winona, Minn.
State Normal School, Whitewater, Wis.
State Normal School, Platteville, Wis.
High School, Marshall, Mich.
High School, Clinton, Ill.
High School, Atchison, Kas.
High School, Denver, Colo.
High School, Madison, Wis.
High School, Kankakee, Ill.
High School, Winona, Minn.
High School, Berlin, Wis.
High School, Litchfield, Ill.
High School, Olney, Ill.
High School, Galesburg, Ill.
High School, Red Wing, Minn.
High School, Aurora, Ill.
High School, La Porte, Ind.
High School, Plymouth, Ind.
High School, Menominee, Mich.
High School, Marinette, Wis.
High School, Dodgeville, Wis.
High School, Omaha, Neb.
High School, St. Paul, Minn.
High School, Elkhart, Ind.

And several hundred Ward School buildings scattered over the country, South to the Gulf States, East as far as Pennsylvania and Vermont, West to Colorado, North to Minnesota, and within a radius of five hundred miles of this city a great many.

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G. P. Randall.

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TO THE PUBLIC.

I distribute this pamphlet, gratuitously, for the purpose of advertising my business, and while this is directed more especially to school boards and educational men generally, I would not have it supposed that my work is exclusively in this line of buildings, though I have designed both of school houses and churches probably five times as many of these buildings as have fallen to the lot of any other architect in the Northwest. My business is largely, though by no means exclusively, on public buildings. I design hotels, private dwellings, stores, banking houses,—in short, almost everything for which the services of an architect are required. If in addition to the designing, clients desire my services in superintending the work, they can have them if within a radius of five or six hundred miles of here, and within that distance I can do it thoroughly and well, though I am aware that the general opinion among those who know little or nothing about it is, that at such great distances an architect cannot do such superintending. This is a great mistake, for with a good contractor, the architect can always give the work all necessary superintendence if he looks it over once a month, which is the usual custom outside the city wherein is located his place of business; and if the contractor proves to be a man who through trickery or ignorance does not do his work fairly, I always have a clause in the contract by which I can, if necessary, employ an inspector, and charge the expense to the contractor. This will generally bring them to a sense of duty. But a visit of inspection once a month, from and by an *expert*, will do more toward keeping the work going correctly, than the services of a dozen local mechanics or school directors watching it all the time.

this fine conception in church architecture, and there is a man in New York who is heralding this falsehood by circulars sent broadcast all over the country. He claims that the Tabernacle, built in 1870, was the first church built in this style, but unfortunately for his unfounded claim to other people's "thunder," a stone tablet built into the walls of the Union Park Church says that it was erected in 1869.

The church was deemed so great a success in its conception that Mr. Bowen, of the New York *Independent*, came here and had drawings made of the exterior and interior, showing the new feature in church designing, had it engraved, and published, and scattered over Christendom, wherever the *Independent* was read, 125,000 copies of this improved church architecture. Since then Union Park Church has been the model that all have tried to equal.

The Baptist Church, Grand Rapids, Mich., the Congregational Church at Mansfield, O., and Madison, Wis., and the Universalist Church, Minneapolis, Minn., are among the best churches in the country, and all modeled substantially after Union Park Church of this city. The large Westminster Church, now building at Minneapolis, Minn., is from a design by Randall & Miller, made some three years since, while Mr. Miller and myself were associated in business.

Previous to the great fire, as well as since, I have designed an immense number of churches of all grades and sizes, that will compare favorably with a like number in any part of the country.

I can make designs for small, cheap houses on the amphitheater plan, as well as large ones.

BIOGRAPHICAL.

I am now (November, 1883) nearly sixty-three years old. I was born and raised a mechanic, my father having been a practical builder and millwright before me, which business I followed chiefly till twenty-one years old. Then I commenced my architectural studies in the office of Ashar Benjamin, of

Boston. At the age of twenty-five and till thirty years old I was engaged in the engineering departments of the Vermont Central (now Central Vermont) and Rutland & Burlington railways, after which I came west and have been actively engaged in the practice of my profession ever since.

In the construction of heavy buildings I have realized the advantages gained by my early railway and engineering practice, and I have since kept up the study of that branch of my profession as a valuable auxiliary to my profession of architect.

In later years I have made scientific studies my chief recreation, some of the results of which will be found occasionally outcropping in these pages.

ADVERTISEMENT.

In the past twenty-seven or twenty-eight years that I have been doing business in this city I have designed a great number of school buildings, more, probably, than have fallen to the lot of any other architect in this city, or in the Northwest, and from time to time, as I have found opportunity, I have published pamphlets containing cuts of such as I have thought would interest school boards, and be regarded by them as such models as they would like to copy.

Those published heretofore have met with an unvarying success, and not only have aided school boards in determining what they wanted, but have made me, for my trouble, a fair return by a liberal increase of business in that specialty.

Hitherto I have generally inserted only the perspective or exterior views, but in this one I have given the interiors also.

Now, it should be understood that I cannot afford to throw away so much time, money (some thousands of dollars) and labor for the benefit of school directors and school boards alone. It is only fair when having done this, and aided them so much in determining what they want, that they should reciprocate, by giving me their orders for architectural service in the construction of their buildings. The pages of this book are intended to show my ability, or want of ability, to design

such buildings; hence if school boards want my services, they must give me a *fair* trial, and then if I do not succeed in making them what they want, they are at liberty to try some one else, but one at a time is sufficient.

I am constrained to say this for the reason that school boards, like individuals, do not seem to realize the great expense of getting up such designs, but seem to understand that architects can do it for recreation or a pastime.

I have often found that after spending fifty or a hundred dollars in designing a building, and perhaps weeks of valuable time, and, what is more, after making just such a design as they have said they wanted, that some architectural tramp or "local" professional would put in his claim, and by under-estimating the cost of his building, or by offering to make plans for less than they would cost me, or by other means or subterfuge which boards should not recognize, get the work away from me. If boards do not find on these pages designs that exactly suit them, let them refer them back to me, and if I do not succeed in making what they want, then I will step down and let some one else try. But I do not send these pamphlets gratuitously to school boards as their property further than as they are disposed to use them for the advancement of my interests. They are protected from illicit plunder by GOVERNMENT COPYRIGHT, which covers not only the text, but the plates and cuts as well, so that they may not be partially or wholly appropriated in any or all their parts without my consent.

I will be obliged to any school boards into whose hands they may fall, if they will preserve them in the archives of the board, for the benefit of themselves and their future successors in office.

If sent to mechanics or other individuals, or if they fall into the hands of such, they are to be subject to the same conditions.

For the reason that I furnish such drawings at a somewhat reduced rate, and not wanting to fix prices on other people's work, I do not name my commissions for such work here, but

will do so in each individual case, if the parties wanting plans will write me, stating substantially what they want to build, the size or number of rooms in the building, etc.

What DATA should be sent an architect when plans are wanted?

In ordinary plans for a school building, the architect will want a rough pencil plat of the lot, with dimensions marked on it, and a brief description of its general surroundings, and POINTS of COMPASS. Do not forget this latter.

Then we want to know how many school rooms there are to be, with the number in a room, and whether seated with single or double desks.

Give us also the general direction of the portion of the town from which the building will be most seen, and the principal approaches.

State the nature of the soil, and whether dry or wet, and whether the ground or site is high or low as compared with the street or streets and other surroundings; say if other buildings adjacent to the lot are high or low, and from which direction the prevailing winds blow.

State the general character and quality of rubble stone to be used, and facilities for getting it; also if cut stone and brick can be obtained.

And, lastly, say about how much you expect the building to cost.

Unless you select a plan from this book, the approximate cost of which is indicated in the book, I cannot be responsible for the cost of any buildings that I design only to indicate their general cost, and mainly for the reason that their actual cost depends on the judgment, or want of judgment, of the contractors who build them.

I do not build such buildings further than to do the work allotted by custom to an architect; but after making the design or sketches, so as to get the cubic feet in one, I can approximate the cost as nearly as half a dozen contractors would estimate it in competition. To enable school boards to approximate the cost themselves, I will say that in the past two years

good substantial brick houses have cost from $2,500 to $3,000 per school room in all parts of the country. As a general rule, where labor and material are about at an average price, these buildings will cost about an average of these two prices. This is as near data as any architect or builder can give, and is sufficient for all practical purposes. Some people seem to think that an architect can make plans for a school building that will just meet the appropriation that a board may make, but this is a very grave error. It cannot be done without a great and unusual expense on the part of the architect.

No architect of integrity will be idiot enough to undertake to guarantee the cost of a building nearer than this. But the data in this book will be found all-sufficient and reliable for determining the cost of any school-house building.

ARCHITECT'S FEES.

There is no one thing connected with professional service of more importance than that of what is the proper fee to be paid for full professional service of an architect. This fee, of course, presupposes that the architect is a man of mature years, and of sufficient age and experience to command the confidence of those who employ him. Till he acquires this knowledge and experience, the law that governs trade generally will require him to take a back seat till such time as he is a peer of those who have already gained that more elevated station.

For the twenty seven years that I have made a specialty of designing school buildings, I have been doing so much of it that it has enabled me to make a liberal reduction in this fee for this kind of work. This general fee, and the reduction, I have embodied in a general fee bill, which I will forward to any school board or individual on receipt of information of the extent and character of the work for which they want my services. I take this method of getting at it because I do not want to be instrumental in fixing the value of the services of my brother architects, nor do I allow others to fix the value of

mine. Again, it *costs* at the present time to do such work nearly double what it did fifteen or twenty years ago, for the reason that builders have different methods at present from what they had years ago, and architects have to conform to and keep pace with the general improvement. I will say here, however, that the discount I shall make from the general price presupposes that the drawings will be paid for within a reasonable time, say thirty days from delivery, for the margin of profit is too small to admit of unnecessary tardiness in paying for them. If, however, for any reason a school board is not prepared to pay as soon as this, other conditions or terms can be made.

GENERAL PRINCIPLES OF RUTTAN VENTILATION.

When I commenced writing this pamphlet I intended to publish the DETAILS of the Ruttan Ventilation for the benefit of "all the world and the rest of mankind;" in other words, intended to give a clear and succinct demonstration and illustration of WHAT I KNOW ABOUT VENTILATION, but circumstances and the advice of friends have modified my intentions, and hence I now propose to state the GENERAL PRINCIPLES only, mainly for the benefit of School Boards and non-professional men, who, it is hoped, will be better clients as they come to understand what they need by way of ventilation in their school buildings, and by way of helping the PROFESSIONALS to understand how to apply the details of this system of ventilation correctly. I shall, at no distant day, publish what I already have in manuscript, a complete elucidation and illustration of the Ruttan System in all its details, and a complete explanation of the application of the same to school buildings generally. The pamphlet referred to will be made to SELL, and, though the price is not definitely fixed, it will be two to three dollars, more or less. The writer of this claims to have aided the successors of Mr. Ruttan in improving his system of ventilation in some or most of its essential details, and in eliminating from it some of its most crude and impracticable features with which it was encumbered when he left it. All

these things will have their place in the forthcoming book mentioned.

PRINCIPLES OF RUTTAN VENTILATION.

The leading feature of the Ruttan System of Ventilation is to introduce the warm air into the room through the floor or somewhere between the floor and ceiling, and exhaust it out of the room through the floor or through a perforated base, from whence in passing out of the room it goes under the floor between the joists, which are raised on top by cross-furring them up, thus enabling the air as it passes from the room to move in any and every direction, crosswise as well as between the joists; and at some point under the floor it is taken down to the cellar in a flue or flues, where it is connected with an exhaust flue that takes this foul air up and out of the building. This is sometimes designated as the downward exhaust principle. At other times it is taken from under the floor directly into an UPWARD EXHAUST flue out of the building above the roof. This is regarded at present as the best practice, but this is Ruttan IMPROVED.

HOW IT WORKS.

The fresh warm air coming into the room at any point rises at once to the ceiling, and spreads out in a level zone under the same. As this air flows into the room the exhaustion at the base commences and so long as the warm air is kept flowing the ventilation goes on automatically without cessation.

An essential advantage of this kind of ventilation is that the warm air always at the upper part of the room is continually drawn by this exhaustive power from the middle and upper part, toward the outside periphery and floor of the room where the cold from the windows and wall surfaces is continually cooling the air by contact with these exposed surfaces, and then falling to the floor, if not at once taken out of the room through this perforated base, would slide along on its surface, forming

a zone of cold air around the children's feet. There is a double advantage in this, that the warm air is continually drawn toward the coldest part of the room, where it is most needed, while the coldest air in the room is drawn out as continually from a part of the room where it is least needed.

It is often practiced by men who know but little about ventilating to let the warm air into the room by a flue or rather register in the floor or through a register just above the base and then exhaust it out of the room *via* a register near opening into a flue somewhere in the room. I hardly need inform any intelligent man that this is not the way to ventilate a room satisfactorily, nor is this way of doing it, RUTTAN VENTILATION. It will only change the air a little in the middle of the room through the agency of a rotary current produced by the movement of the air going in and coming out and it is almost certain to keep the air from being changed in remote parts of the room, and certain to keep the cold places remote from this moving current in an uncomfortable condition all the time.

Mr. Ruttan's theory was to take the cold and foul air out at the floor or near it in small jets, so small that scholars sitting in the vicinity would not have their feet and legs chilled by the moving currents. There are some architects who exhaust the cold air out of a room by setting registers in the floor, with exhausting ducts between the joists leading to the outlets. This too, is wrong for the reasons just given, that the currents of air moving from every direction on or above the surface of the floor toward these exhausting registers would soon make the feet too uncomfortable to be tolerated. In a school room artificially warmed and ventilated, every care should be taken to get the fresh air into, and the cold and foul air out of a room with the least possible amount of air currents that would strike any portion of the body.

There is another part of this process of getting fresh air in and foul air out of the room that mystifies people sometimes, that I will endeavor to explain. Persons sitting in the fresh air at every respiration vitiate a portion of the air by throwing off from the lungs a portion of carbonic dioxyde, or acid, a

poisonous gas that immediately mixes with the fresh air; hence the latter soon becomes overcharged with it, so that it becomes foul and unfit for respiration. Now this difficulty is gotten over by diluting the bad air by the introduction of a large volume of moderately warm air into the room, and this dilution is kept steadily going on as it necessarily must, and in this way the air in the room is kept in a condition for respiration.

Keep this one thing in perpetual remembrance whatever system of ventilating you are using, that VENTILATION IS ALWAYS AT THE EXPENSE OF HEAT, and probably the expense in this system, as compared with others, is a *minimum.*

It is claimed by some that the carbonic acid (dioxyde) gas, being so much heavier than common air, at once falls to the floor at every expiration, and that an advantage of the Ruttan ventilation is that, going to the floor, it at once passes out of the room without mixing with the pure air we breathe. It is pleasant to *think* this, if it be so, but when, at every expiration, we throw off this gas warmed to blood heat, it may be a question whether, instead of falling to the floor, it may not be light enough to obey the law of the "diffusion of gases," which operates without much reference to their condition as to temperatures.

Observation, however, has satisfied me that this gas in a cold state falls to the floor, but when thrown off from the lungs in a rarefied condition, or when it is the product of combustion, it will in this highly rarefied condition rise upward toward the ceiling, but when the room is allowed to cool it becomes heavy again by condensation and falls to the floor.

A ROOM MUST BE HEATED WITH WARM AIR IF WE WOULD VENTILATE IT.

It is no unusual thing for a School Board, for the sake of economy, to order plans made for a house to be heated by stoves, but they "want good ventilation." Let us investigate this matter a little. A room to be ventilated must have its air warmed before it comes into the room. This is called indirect radiation. The heat from a stove radiates to the surrounding objects, and will only radiate its heat in this way

when there is no intervening object between the radiator and the object to be heated. A slight percentage of heat is thus imparted to the atmosphere through which the ethereal waves pass that produce the heat. Thus we see that heating with stoves, as with coils of steam pipes set in the room to be heated, is to heat the air, whether pure or already fouled, over and over again, but this produces no ventilation. To produce ventilation, as has already been said, pure warm air must come into the room as the cold or foul air goes out.

Hence with stove-heating, or heating with ordinary steam coils in the room, no ventilation can be had save any such as would be produced by the ordinary defects in the windows and doors, and leakages of this kind are very bad ventilation. Air in cold weather should never be allowed to come into a room in this way. It finds its way by its gravity to the floor, over which it spreads in a zone, and no room can be comfortable where such a condition of things exists.

As a general rule, in arranging the HOT AIR flues for a school room I aim to have their capacity a little in excess of that of the exhaust. In this way we get a gentle pressure in the room, which operates to keep the wind from driving into the cracks and crevices—the result of imperfect mechanical work in the construction of the room.

MODE OF HEATING.

To produce satisfactory ventilation does not, as some people suppose, require any particular method of generating heat. This may be done by the use of hot-air furnaces or by steam coils, as shall best suit the circumstances. A complicated building, like that of the St. Paul High School, for instance, on these pages, is best heated through the aid of steam pipes, but a simple ward school house, with its school rooms one above another, can be heated as well by furnaces as with hot-air coils, and the same arrangement that will answer for one will be right for the other, as I construct such buildings.

And here comes in the place where School Boards, unless they consult a competent architect, are certain to get misled in determining what heating apparatus they will use, for remember I have explained that to ventilate successfully requires a *large volume* ot warm air. It is seldom that a furnace can be found that will furnish this air in sufficient quantity to both heat and ventilate. A heating engineer may provide just the amount of heat and volume of air to heat the room to the proper temperature, and still twice this amount may, and probably will, be necessary to heat and VENTILATE the room, for however well the rooms may be provided with ventilating apparatus, they will not ventilate if they do not have capacity to furnish the requisite quantity of warm air and keep it passing through the room in a proper manner.

Many have been the failures in attempting to ventilate these buildings, because School Boards, as well as the architects they employed, were ignorant ot this one fact. There are a great many furnaces the venders of which will emphatically declare that they are amply sufficient to do the work, and when it comes to trial, if they succeed in *heating* the building, the Boards are easily persuaded that the heating contractor has filled his contract, and afterward, if the building does not ventilate, they console themselves with the reflection that *they* have done their duty, but that the architect has failed to do what they expected of him, viz: to ventilate the building.

SUB-EARTH VENTILATION.

Having explained substantially the principles on which Ruttan ventilation is founded, I propose to introduce here a subject that is probably new to most of my readers, though I published in the "Chicago Tribune," in the month of May, 1874, a full description of one of these ducts, then in use near Harvard, Ill.

They consist of a duct or tunnel built under ground by turning an arch of light rubble stone, making this arch of a form approaching that of a semicircle, but it should take the best form for strength considering the nature of the soil where it is built and other things that might affect it.

These ducts are best laid at a depth in the earth that is called the neutral point, that is to say, a point not affected by the rays from the sun in the summer nor the earth's internal heat in the winter, and this depth in some countries — England, for instance — is said to be about twenty feet below the surface. Practically, however, I suppose from eight to ten feet under the surface will do pretty well.

We will suppose we are ventilating a School House through such a duct as the working inlet for fresh air. Its maximum effect is best attained when the duct is good length, and if the reader wants to know what we call good length I will say 400 to 600 feet long, but I have never seen one more than 180 feet, and that a small one of about a square foot of cross section. But a longer one would bear a cross sectional area of eight or ten feet or more. All these dimensions have to be proportioned to the work they are expected to do.

Having determined the dimensions, it is to be set in the earth so that the discharging end will be under the building, and where it can easily be connected with the fresh air chamber or chambers that are to feed the furnace or rooms to be ventilated. Extend the duct to such length as circumstances will warrant, and then, at what we will call the inlet end, construct an air shaft of like area with the duct, and this may be built up from the duct in the ground to some few feet above

the ground, and should be constructed with an injecting, revolving cowl. This done, the tunnel-shaft will be constructed of stone, as the best material for conducting heat. If stone cannot be had, brick will do very well, though the conducting power of brick and stone are about as 5 to 15 or 16. Of course, then, stone is the best of these two materials, but for that matter iron is much better than either, on account of its superior conducting power.

In the construction of these ducts it is claimed that only the arch, if the cover be an arch, should be stone, but that the lower side of it should be surfaced with a dressing of clean clay, on account of that property in clay that takes all impurities out of the air that comes in contact with it; in other words, its quality of absorbing all deleterious gases, etc. If the depth of earth above our duct is not too heavy it may be covered by two stone flags in a triangular form, or set sloping like the two sides of a roof, with the clay surfacing across the bottom or third side of the triangle. When the mason-work is built the ditch above the duct should be filled in to the surface, or above, with earth well packed.

The largest one of these ducts of which I have any knowledge is at Muscatine, Iowa. It is several hundred feet — I have forgotten whether 400 or 600 feet — long, is built of brick, and is large enough in its sectional area for two men to walk abreast through it.

Having gotten the thing built, as we think, on scientific principles, let us examine its working and study its effect.

Such a duct will not only help to cool our building in the summer, but will aid materially in warming it in the winter. And how is this to be accomplished? How shall we extract heat from the earth that shall impart its warmth to the air passing through it in the winter, but cool it in the summer?

At this writing I have not the exact data on which to base the effects produced by passing air through a duct such as we are contemplating, but we will note the effects of passing it through one I have seen in use and noted its effects. The one I refer to is the one near Harvard, Ill., and is (or was when I

examined it) owned and used by Mr. Charles W. Sylvester. It was 180 feet long, with a cross section of less than a square foot, and was laid seven feet below the surface of the ground. I visited and examined this duct in the forenoon of May 20, 1876. On that day at 9:30 o'clock the thermometric indication outdoors, or at the inlet end of the duct, was 78°, and it entered the cellar at 48° Fah. Mr. Sylvester assured me that this duct had never delivered the air into his cellar at less than 40° above when the outside temperature was at 26° below zero; hence the temperature of the air was raised 66° by absorption in passing through this duct, by the internal heat from the earth. This absorption, it will be understood, is greatest when the covering of the duct is a material that is a good conductor of heat.

I have found by inquiry that air ducts of proper length and depth deliver air at about 50° above, at all times, regardless of the extremes of the out-door temperature.

Mr. Sylvester stated that he had always been obliged to bank the walls of his house, but after using sub-earth ventilation two winters he concluded that the duct was capable of warming not only his entire cellar but the house as well; so last winter he omitted the banking and allowed the duct air to circulate throughout the cellar. He found that the temperature never got below 40°, and that it made a great saving of fuel in the house.

Let us endeavor to make a practical application of the principle of this sub-earth ventilation to the heating and ventilating of a schoolhouse, and we shall see that the principles involved will apply to every kind of a building necessary in a civilized community.

We will suppose that in our school building the arrangements for heating and ventilating are such as a scientific engineer would approve, and we want to give the several schools the benefit of sub-earth ventilation. The first thing to be done is to double the windows, and generally to make the room as close and tight as possible. This is substantially all the change that will be required in the building itself.

Then we construct the air duct of the proper size, form and length, and connect it in a proper manner with the several rooms to be ventilated. No expense whatever is incurred in the use of it, except a fire in a small stove in the exhaust shaft in the summer.

In this way, when the temperature is 100° in the shade outside it will be toned down inside to any comfortable temperature from 60° to 70°, and much lower if desirable.

For winter ventilation this air entering the sub-earth ventilating duct at zero, or even at 40° below, will be delivered from the duct at about 50° above, it having absorbed heat from the surface of the duct, so that in case the outside temperature is 40° below, air transmitted by the duct will be warmed 90°, and will only require to be heated by artificial means 20° to bring it to 70°.

The warm natural air, as it enters the duct and passes along through it, is cooled down to about 50°, and is thereby made to precipitate its moisture on the walls and bottom of the duct, so that when it enters the room it is thoroughly divested, not only of its moisture, but the deleterious gases are absorbed by contact with the earth, and it is then in a condition for respiration. For the cellar of a dwelling, for preserving vegetables, meats, and other substances from decay, such as has given the climate of Colorado and the Pacific Slope a world-wide reputation for the purity and life-giving quality of its atmosphere, it is unequaled. Milk will remain in such an atmosphere long enough for all the cream to rise before it sours, and in this Sylvester duct the black iron pipe, through which the air passes from the duct into the room, is not damp nor corroded in the least, so completely is the air divested of its moisture in passing through this duct. Admitting, then, these facts, who can doubt for a moment that it is such an atmosphere as we ought to breathe in our houses, and, above all things, in our sleeping rooms, where we spend one-third of our lives? How many are there in this city of Chicago, who spend money for palatial residences and ostentatious show, but who, perhaps through ignorance of even the existence of such a contrivance

as a sub-earth air duct, deprive themselves of one of the greatest luxuries, which they might have at a moderate expense, that has ever been vouchsafed to man.

To state another case, suppose the temperature outside to be 10° above zero. The air can be introduced through such a duct to the building at about 50° above. Now, in this case, we draw from the earth 40° in 60° of the heat necessary for supplying our school rooms, and furnish the balance, or 20°, by the combustion of fuel. By this it will be seen that we save *two-thirds* the fuel by utilizing the heat stored up in the earth, and this saving will, in a brief time, compensate for all the expense in constructing the duct. Let no one who reads this suppose that the ventilation in buildings in the manner here described is something chimerical, or that it is impracticable in its execution. It is in use in various ways, I think, in some fourteen States of the Union, and in all cases, where skillfully constructed, is giving the best of satisfaction. It is one of those invaluable improvements that is, perhaps, in advance of the age, but it will slowly and surely find its way into general use. When this shall be the case, families will find it much cheaper to furnish, through the agency of a sub-earth duct, the pure air necessary to health and comfort *at home* than to go 1,000 or 2,000 miles away to find it.

It will readily be seen that this sub-earth ventilation would be of the greatest value and economy in connection with all asylums, hospitals, etc.

In constructing these ducts it will not do to lay them where they will fill with water. If they are to be used in buildings built on small lots, the necessary length of duct may be obtained by running them back and forth, or in any direction, on the lot, to suit convenience, and, if the soil will allow of it, they may be laid under the buildings.

I have thus attempted to describe what I think is one of the most valuable discoveries of the age, and to those who have known me favorably for the past twenty odd years as an architect and ventilating engineer, I have no hesitancy in saying that this is one of the most valuable acquisitions to our

store of knowledge in the science of ventilation that has come under my observation.

Thus we find that a sub-earth air duct is useful in winter in warming the air by the absorption of heat from the bowels of mother earth, instead of producing it in the ordinary way, and equally useful in cooling down the atmosphere in which we "live, move and have our being" in the summer season. It has been said that the owner of one of these ducts — a large one — offered a wager of $1,000 that he would hang fresh meat in the air that passed through his duct for the space of ninety days in dog days, and at the expiration of that time it would not be tainted. It is also a well-known fact that years ago, when pioneers to the Pacific slope were crossing the plains, they could preserve their fresh meat by nailing it to a tree or their wagons, and that the atmosphere in those regions was so dry that not only was their fresh meat thus preserved, but at nightfall they could with entire safety make their bed on the bare earth, with only the canopy of heaven for a covering, so dry was the atmosphere. Now, it is this kind of dry atmosphere which man and woman kind ought to breathe by night and by day. It is in accord with natural law that warm air carries a larger quantity of vapor or moisture than cold air can carry, and if the warm air of summer enters the duct at a temperature of 90 or 100 degrees, as soon as it enters the duct it commences to radiate its heat to the covering of the duct, by which it is absorbed and transmitted to the surrounding earth by convection, and thus its heat is dissipated and absorbed by the cooler earth. In winter, as I have already explained, this process is reversed, and the heat already stored in the earth by the operation of the sun's rays in summer, and its own internal heat, unite to supply the complement of heat for use in winter. Thus nature is ever ready to lend a helping hand to those who use their brains as well as their hands in procuring the comforts of life.

If in the construction of one of these ducts, and it is for the ventilation of a dwelling, it will be fortunate if the grounds on one side of the building be more elevated than that which

is the immediate site of the building, wherein the duct can be buried, or, what is better still, if there is a hill near the building, up which the duct can be laid. For summer ventilation, the air cooled in the duct will gravitate toward the building, and its gravitating force would, without other process, raise the air to all the rooms in the building that are not above the inlet end of the duct, on the same principle that water will find its level in a building with the source of supply, when conducted there through pipes. There are, however, other methods of raising air from the duct to the upper rooms, that are effectual when properly used. These I shall not attempt to explain in detail, as the extent and the character of the building would have to be considered in doing it.

There are other systems or methods that are good in their places, and one that I have in mind that is especially well adapted to church ventilation, but it is not adapted to the ventilation of school buildings. For the latter I regard only the Ruttan system as being of practical use, and in saying this, I would not mean specially to indorse the Ruttan system of HEATING, though no room can be properly ventilated that is not furnished with a large volume of moderately warmed air, WHICH THE RUTTAN FURNACE WILL DO, and this may be done also by steam coils, or in any other manner that will accomplish the object; but I do say that it cannot be done by the agency of any POT furnace that I ever saw or heard of, and the Ruttan furnace, so called, WILL DO IT. It was gotten up for this special purpose. In each individual case that shall be referred to me, I will give my opinion of its and their relative merits as compared with other methods. It is not of such great importance whether steam coils or furnaces are used as a medium for extracting the heat as to have an apparatus that has AMPLE POWER for radiating heat.

Ordinarily, if steam is used for the heating of a school room, it should be by indirect radiation, with a small amount of pipe or coils set in the window recesses, to counteract the effect of cooling at these points *in extreme cold weather only.*

The plans, as I make them, and the arrangement of flues, are the same for either method, but it should always be determined in advance which method is to be adopted, because there are details and the specifications that should always be made for either one or the other, whichever is to be used, if we would save *extra* work.

HOLLOW WALLS IN BUILDINGS.

HOW THEY SHOULD BE CONSTRUCTED.

A salubrious and comfortable atmosphere in winter is best attained when houses are so constructed that they can be heated with the least possible amount of artificial heat.

I will premise that every building that is to be kept cool in summer and warm in winter should be provided with double windows. This is of the utmost importance. No building can be made thoroughly comfortable without these important appendages. The next great desideratum is to so construct walls as to prevent as far as possible the convection of heat through them. To this end it is essential that we use such material as has the least conducting power; hence the importance of our understanding the relative conductivity of the different materials used. Nearly all first-class buildings have their walls of stone, brick and mortar. The cheaper buildings, such as dwellings of a moderately expensive kind, are usually built of wood, and there is perhaps no class of buildings in which we live in the construction of which there is a necessity for so thorough a knowledge of how to build as in this class of houses.

The relative conducting power of the different building materials is as follows:

Stone	14 to 16
Brick	5
Plaster	4
Wood — less than	1

Wood, therefore, is the best material named; but woolen felt is now much used in place of wood, and is probably better for many purposes.

Various considerations, however, may govern our choice and necessitate the use of stone or brick. When this is the case, it is an excellent method to fur the walls inside with ordinary furring strips, then sheathe or cover them with this woolen felt, and against the face of each furring, and over the felt, fur again for lath and plaster. This is an interposition of what we have shown to be a comparatively good non-conductor, and, with an air-chamber on each side of it,—between the brick and the wood on the one hand and the lath and plaster on the other,—it is perhaps the best method of preventing convection of heat through walls. Hollow brick walls are sometimes resorted to, but if the two sections of the walls are so completely separated as to entirely break the continuity of the brick the walls are weakened. It is a popular error that a wide space or air-chamber in a hollow wall is better than a narrow one. This error is founded entirely on a misconception of what heat is, and how it travels through space.

For the purpose of making our demonstrations as clear as practicable, we will assume that the material of our building is chiefly wood, and that it is desirable to prevent the convection of heat as much as possible. For the illustration of a principle, and without reference to stability of construction, we will suppose our wall to be made of a series of close board partitions set a little distance apart to produce chambers for "dead air." We shall endeavor to show that these chambers will be equally efficient as non-conductors whether they be one or ten inches in width, and for convenience of reference we will number the partitions separating these chambers one, two, three, etc.

A beam of rays from the sun is simply a collection of ethereal waves flying through space with a velocity that far outstrips the lightning, and so long as these waves are allowed to continue on in their journey uninterruptedly there is no more heat in them than in the icy regions at the poles; but when they impinge on our bodies, through the medium of our nerves and brain, they produce the sensation of heat. If they impinge on the retina of the eye, they produce the sensation of light.

Now, we will suppose that a beam of these rays, or ether

waves, shall impinge on the exterior of our imaginary house, with its board walls and air-chambers. If it strikes the outside board, or partition number one, in a direction perpendicular to the plane of the board, a much greater portion of the beam will be absorbed and transmitted than if it impinge upon the board obliquely, but in either case a portion of the beam — depending upon its angle of incidence — will be absorbed and transmitted in accordance with the laws of convection, and the remainder will be reflected back into space, or to the surrounding objects, in accordance with the laws of reflection.

When this beam has impinged upon the surface of this partition number one, that portion of the beam that is absorbed enters among the molecules of the wood, and sets them in active motion, one against another, and now, for the first time, our rays become heat. Before they impinge on the wood they are simply motion — a wave in the ether, similar to a wave on the surface of water, and these waves that are reflected off continue as motion, and are only changed into heat when they find a lodgment in some material substance.

We have now advanced to that point in our demonstration where we have our ethereal waves absorbed in the first surface of the first partition from which it is transmitted from molecule to molecule until the heat has found its way through the second surface of board number one, and this transmission is technically called convection. At this second surface the heat is again changed into ethereal motion, and, again taking the form of a wave, it jumps across the intervening space to the first surface of the second partition. I have said that the distance across this air-space makes no sensible difference in regard to the transmission of heat, and for this reason, that it travels through its medium, the ether, at the rate of nearly 190,000 miles per second, hence, practically, the difference of a few inches, or feet even, is unimportant.

We take our beam where we left it at the first surface of the second partition, but we find only part of it, for a considerable portion was reflected back from the first surface of

the first partition and lost. It is, however, sufficient for our present purpose to know that it has not entered the building.

Our beam, or what is left of it, has been absorbed and again changed to molecular motion, — that is to say, heat, — and another part of it reflected back to the first partition, where it is again reflected in part, and the remainder is absorbed, and transmitted by convection to the first surface of the first board, and sent back into space as ether waves. That portion which has been absorbed by partition number two will be transmitted through this partition by convection, as through the first partition, and so this process goes on from partition to partition, until, if there be enough of them, the whole beam will be turned back and dissipated, and no sensible amount of heat will get into the building.

If walls of brick, stone, iron, or other material are used that have a greater power for absorbing these waves and converting them into heat, a smaller portion of the waves will be reflected back each time, and a proportionately greater number of compartment partitions will be required.

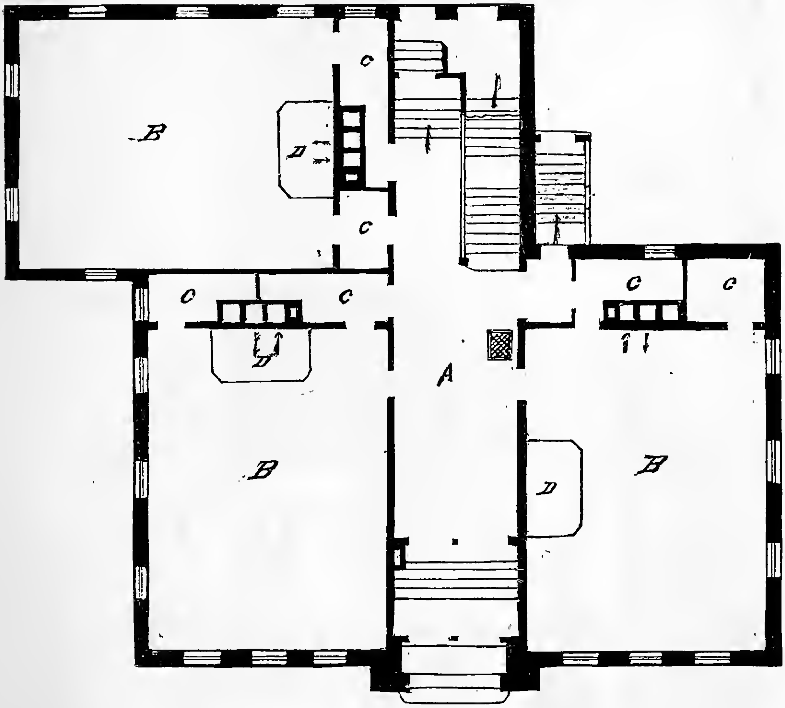
It has been claimed that the wider air-chamber is preferable to the narrower one, for the reason that the ray of heat emerging from a given point diverges, and that its intensity at the next surface on which it falls is inversely as the square of the distance. We admit the correctness of this principle, but we should not overlook the fact that the entire second surface of our partition, instead of giving off heat waves at a single point, is emitting them at every point on its surface, and each and all of these diverging rays are crossing and overlapping each other, so that in fact the same amount of heat that leaves the first reaches the second partition, diminished only by a small absorption of these rays by the vapor in the air-chamber, which is quite too small to be considered in the general result.

The advantages to be derived from a thorough understanding and a skillful application of these principles in the construction of compartment walls by which to prevent the transmission of heat through them, are very great.

Design No. 1. (Monroe, Wis.) Perspective.

EXPLANATION OF THE CUTS.

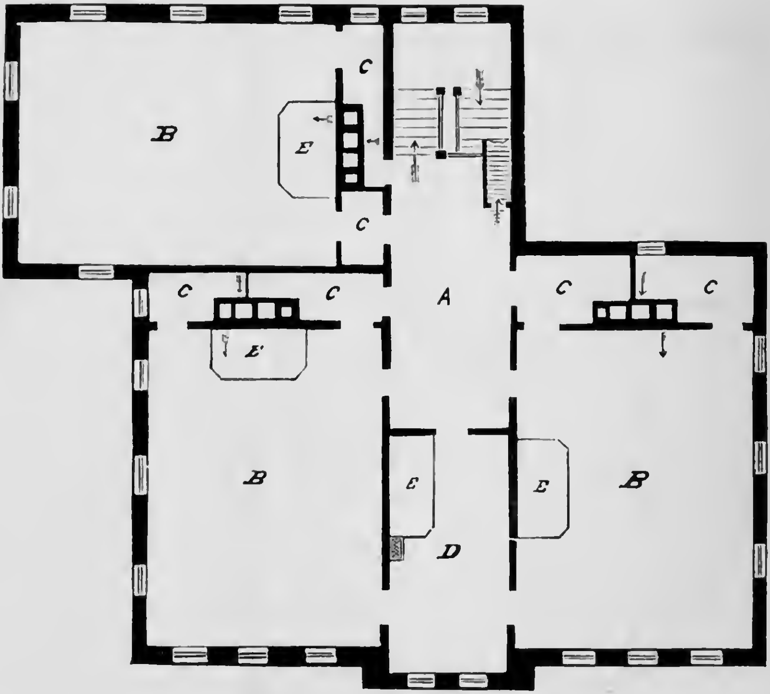
The cuts or floor plans, and their corresponding perspective elevations, form a variety of designs from which School Boards may often select or find a set that will meet their particular case. If they do not find such an one or one that is exactly right, if they can find one that is nearly so they can



DESIGN No. 1. FIRST FLOOR.

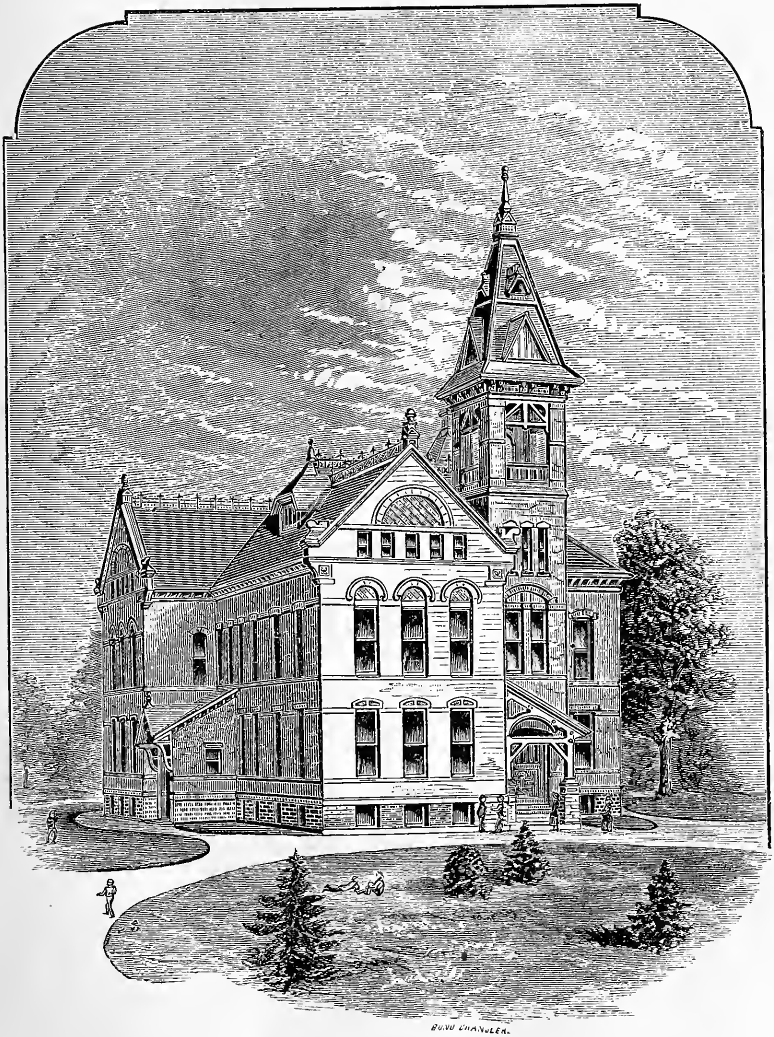
send it to me and have it modified till it will be right. If accompanied by an order for full drawings and specifications, or if such an order follows the making of such modifications, no charge will be made for this work beyond that of the regular commissions that I charge for such work, or the standard commissions less the discount, as elsewhere explained.

We will begin this explanation of plates with a six-room school house now building at Monroe, Wis., at a cost of $13,851 exclusive of architect's fees and local superintendence. This building has six school rooms, lettered B B B on floor plans, three above and a like number on the first floor. D, on second floor, is a principal's room, or it may be used for a



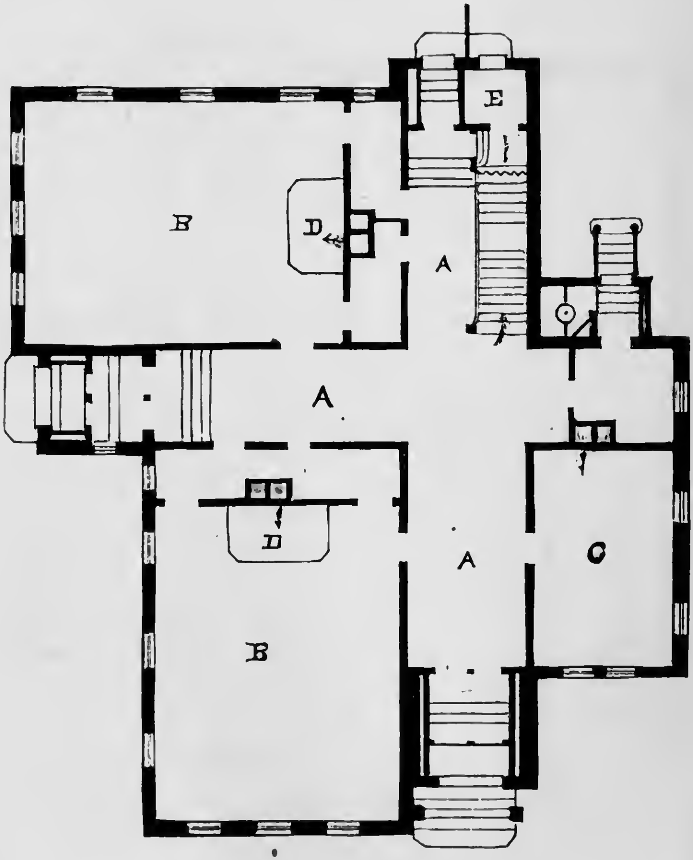
Design No. 1. Second Floor.

recitation room, library or apparatus room, etc. If the latter, E is a case to keep the apparatus in. The outside walls of this building are plain brick, with brick partitions in the basement and studded partitions in the first and second stories. The dimensions of the school rooms proper are 25×33 feet, calculated for sixty-four scholars in a room at double desks. The school rooms have each two closets, C, C, one for boys



DESIGN No. 2. PERSPECTIVE.

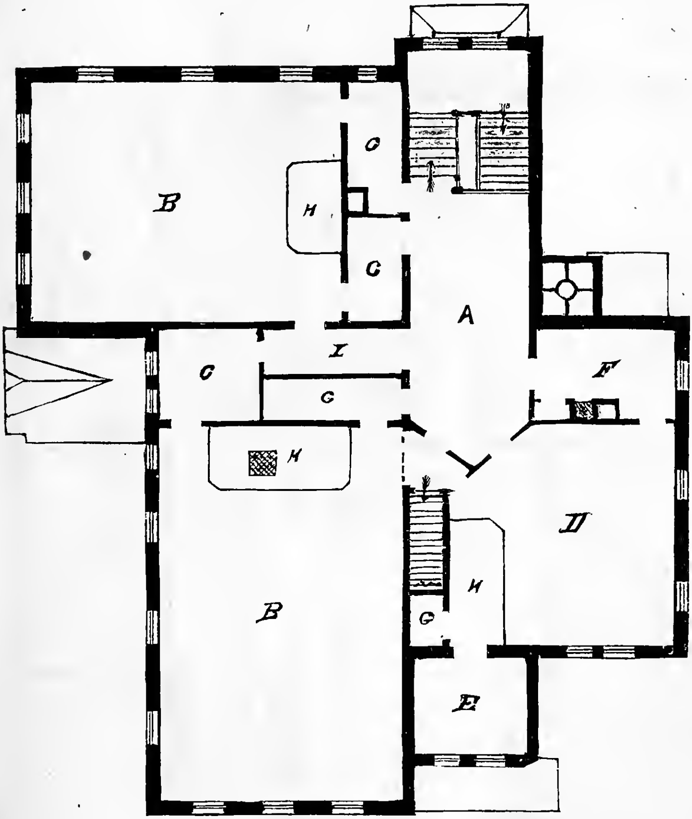
and the other for girls, all finely lighted, and the school rooms will be finely ventilated if properly heated. They get this building erected at a minimum cost, and for the location it will be a good house if well built. It has no tower, belfry or bell.



Design No. 2. First Floor.

This is a design for what is equivalent to a five-room house intended for the village of Almont, Mich., but was not built on account of its expense. It was intended for a high school, and has a large room, B, on the second floor for the

high school proper, which room is larger than the others, and has a recitation room adjacent, with an apparatus closet, E, off from it. It also has a principal's room, C, with the usual clothes closets for the sexes. It is provided with two rear

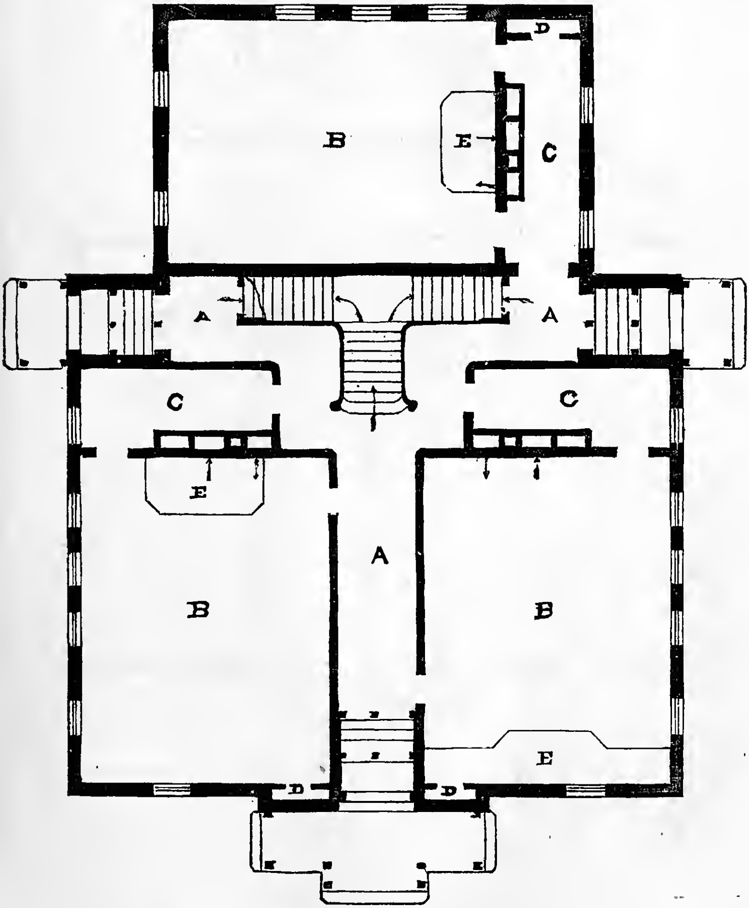


Design No. 2. Second Floor.

entrances also, for the purpose of separating the sexes as they go to the back yards. This house has its tower in front to the east; also a side entrance fronting on a side street and looking toward the town. The room C, on first floor, is for an office for the meeting of the School Board.

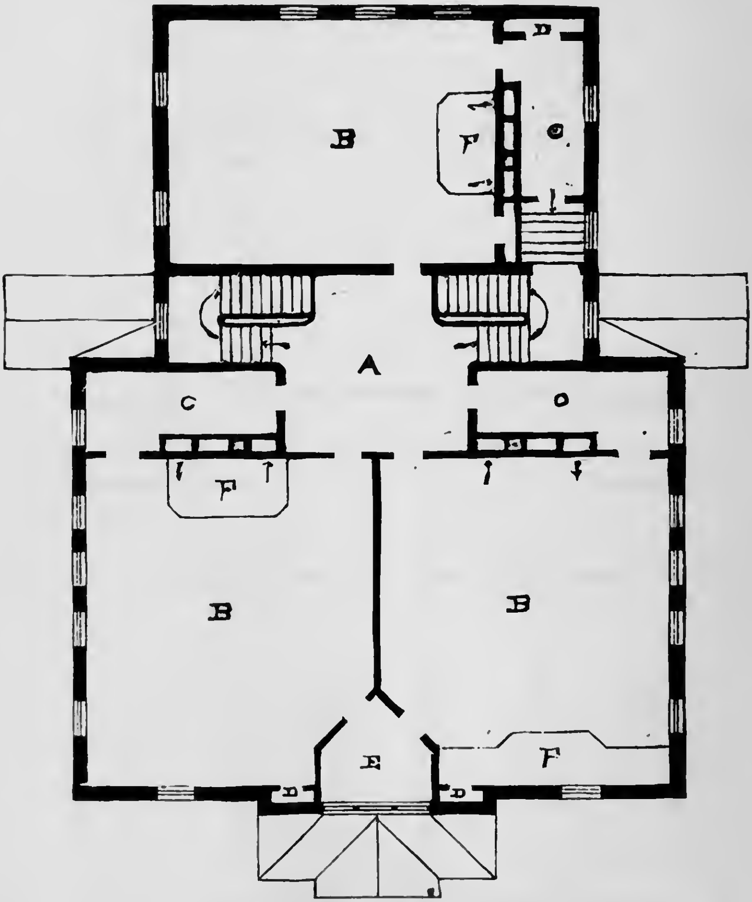
Design No. 3. Perspective. (Not built.)

Owing to its unexpected cost, on account of an unusual cost of getting material on to the ground, there being then no railway facilities there, it was abandoned, and another design has since been made for it and adopted. By enlarging the board room and making a school room of it, and a school room of the recitation room over, it would be a first-rate six-room house.



Design No. 3. First Floor.

Design No. 3 is for a four or six-room house, and may be built a four-room house at first and afterward have two more rooms at the rear, making it a six-room house when complete.



DESIGN No. 3. SECOND FLOOR.

It is a thoroughly good design for such an object. The part first built will extend back to and include the wall back of the stairway, with its hall, outside doors and their vestibules on each flank. The reader will observe that in all these designs the

light is on the rear and left of the scholars, which at the present time is adjudged by educators to be the proper place for it. Fifteen years ago but little attention was given to such details.

Observe also that at the outside doors of this and all the designs in this book the stairs are in part outside of the outside door and the balance of them inside of this door or in the vestibule. This saves expense, because the steps outside of the outside door should be of stone, while those inside or in the vestibule can as well be of wood. It would be better, on account of snow, ice and the broken heads scholars sometimes get falling on the arrises of the stone, if they could all be made of wood, but wood outside the building would not be desirable.

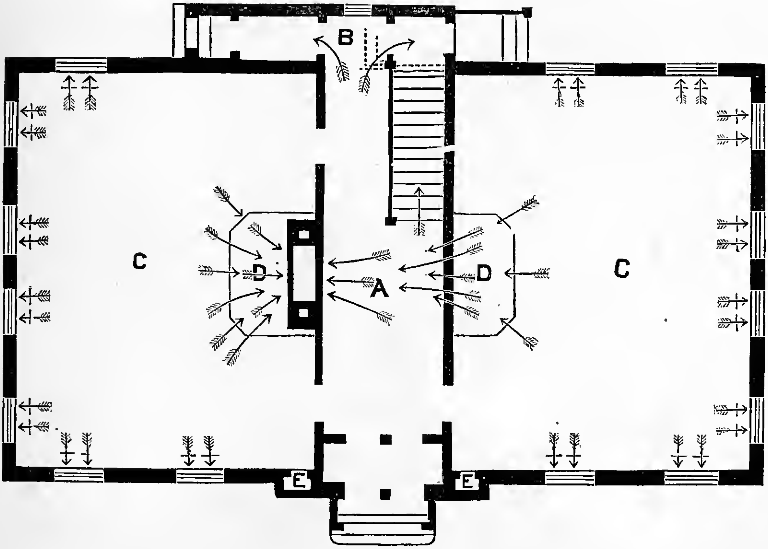
This house has a little more expensive finish on the exterior than is necessary for a plain building, and it ought to be faced outside with a good quality of pressed brick. It would cost $16,000 to $18,000 for the six rooms complete.

Any School Board that may be pleased with the interior arrangement can have a different elevation and a much plainer one, indeed a *very* plain one, made to fit. The most of the designs in this book are made to suit the peculiar ideas and financial conditions of some School Board, but can be modified to suit others.

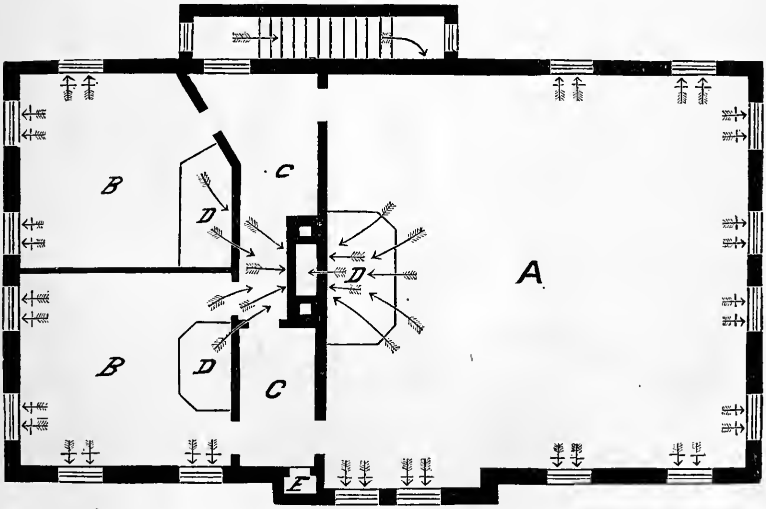
Design No. 4.

This design is for a cheap brick house — cheap because it is not provided with all the apparatus for ventilation that a school house should have, etc. It is not arranged to have a cellar nor furnaces for heating, but has a good ventilating shaft, and if the rooms are kept warm they will ventilate to the extent of ejecting all the surplus air out of the rooms that gets into them from any source. This arrangement is the best and cheapest that can be made without the introduction of fresh warm air into the room for warming it. In other words, it is the best that can be made with direct heating, or heating by stoves. Otherwise than for its want of a correct system of heating to accompany its ventilation, it is a cheap house and

Design No. 4. Perspective.



Design No. 4. First Floor.



Design No. 4. Second Floor.

all right. It has a central hall, in which the scholars will hang their clothing, and from it a stairway to second story. It has two rear doors, one for each of the sexes, by which to go to their respective back yards, and a double entrance at the front.

There is but one flue stack, the large one in the center to be a ventilator, and the smoke flues on each side for each of the rooms. In each story one of the flues will have to cross the hall. These smoke flues on either side of the ventilating flue will warm it and help to give it some current.

The second floor is subdivided differently from the first, but can be made into two ordinary sized rooms, like the floor below, if desired, in which case the stairs would land in the main hall ; there would be a principal's or teacher's retiring room at the front, and the projection at the rear could be dispensed with if desirable.

Such a house would probably be built for from $7,000 to $8,000, though it has not been estimated.

Design No. 5. (Not built.)

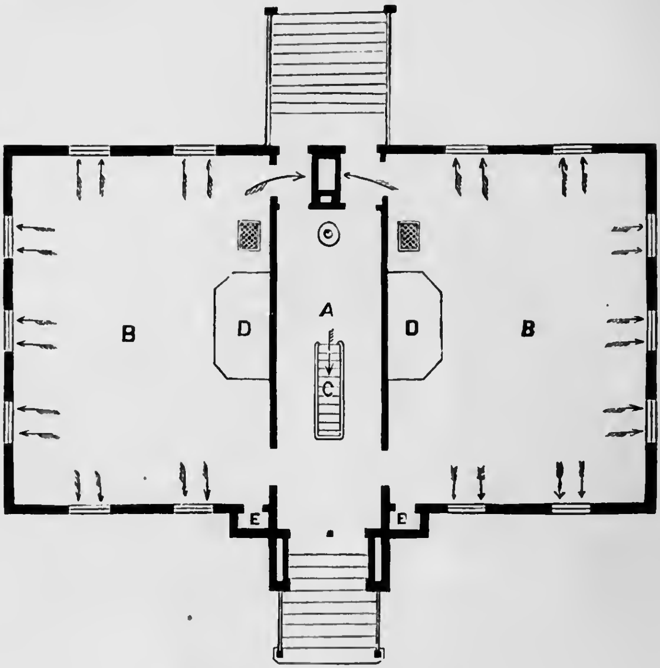
This design is for a two-room frame building and one story high, and by a good builder has been estimated to cost complete about $4,300. It is a very cheap building, and, as I think, a very neat and tasteful one. The arrangement inside is simple. B B are school rooms, A the hall, along the sides of which, and the low partition inclosing the stairway to cellar, the children can hang their clothing. There are two rear doors, one for either sex, and the stairway outside these rear doors and the doors should be separated by a high and close board partition that should lead to and separate the privies at the rear in like manner.

From the stairs along each side of this fence should be walks leading to the privies, and to make this part complete these walks may be covered and inclosed on the outside with lattice, so as to partially screen the scholars as they go to and from. The fence, walks and privies are not included in the estimate named above.

DESIGN NO. 5. PERSPECTIVE.

A slight modification of it would allow of another and third room to be built at the rear, thereby making of it a three-room house.

At the rear end of the hall is a ventilating flue that will ventilate both rooms, the warm fresh air entering the rooms through the registers in the floors and near the teacher's platforms, D D.



DESIGN NO. 5. FLOOR PLAN.

In the hall, in front of the ventilating and smoke flues, is a drum. The building is supposed to be heated by a furnace in the cellar, the smoke pipe from which would come up through the floor and into the lower end of the drum, and be continued from the top of the drum up and turn into the small flue in the stack, which is the smoke flue. In this way the hall would be nicely warmed with the waste heat from the furnace. A nicer

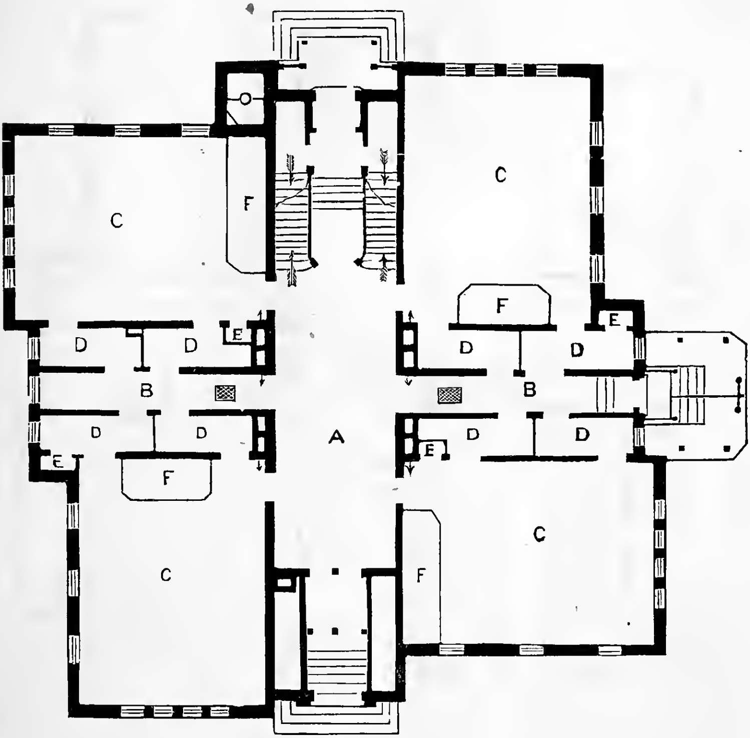
arrangement than this could hardly be conceived for a small school house, and when we take into account the extreme inexpensiveness of the building — but a little over $2,000 per school room — and the exterior neatness of the building, which can always much excel that of a plain brick building, it seems strange to me that School Boards do not oftener build of wood instead of brick. In the manner in which I should build this house it would be quite as warm and substantial as a brick building. The chief difference between the two materials would be that a frame building must be kept painted, and this involves some expense, but the interest on the difference of cost of brick more than of wood would keep the frame building well painted. If built of brick the details of the exterior would have to be changed some, but generally the aspect of the building could be kept about the same as this. Another room on the back side would not injure the appearance of the building at all, whether of wood or brick, but would rather improve it. With a sufficient depth of lot two rooms might be added to it, thus making a four-room house, and all on the ground floor, with no stairs to climb, which are the bane of our modern school houses.

There is at the present time a decided leaning toward the construction of school buildings of one story, and it is very seldom at the present time that I get an order for plans for a house more than two stories in height. School sites are not so scarce in this vast country as to make it necessary to construct a building to exceed two stories in height.

The general opinion that a large building must necessarily look low and "squatty" if but a single story in height, is a mistaken one. And even if this were the case we cannot afford to sacrifice our children — the health of our daughters — in running them up and down stairs to get to and from their school rooms.

Design No. 6. (Marinette, Wis.) Perspective.

This is a high-school building at Marinette, Wis., not yet quite complete inside, but it will cost about $21,000 when finished. The floor plans show very plainly the interior arrangement of the rooms, which are about the usual size and all finely ventilated through a main ventilating shaft on the

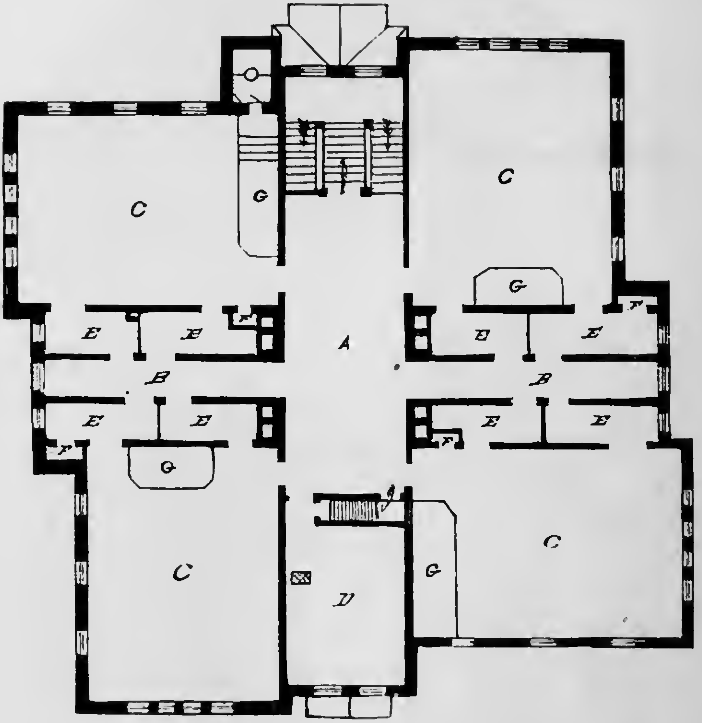


Design No. 6. First Floor.

south front. Its main front is to the north, looking toward the Menominee River and toward the village of Menominee on the other side of the river.

This building is a frame covered with boards set diagonally and then veneered with brick outside the boarding, so that it has the appearance of a brick building.

There are wardrobes for both sexes attached to each school room. Adjacent to the principal's room on the second floor there is a room marked D, that is the principal's *private* room, and which may be used for library, apparatus room, or even a



DESIGN NO. 6. SECOND FLOOR.

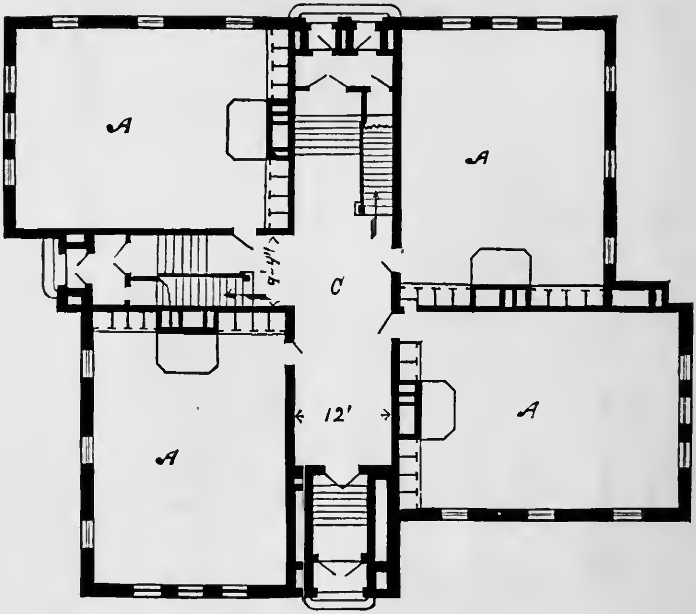
recitation room, if one shall be needed. Its foundations are laid well of rubble stone and in cement mortar, and the cellar floor is of concrete, as in all the school houses I build.

DESIGN NO. 7. (Dodgeville, Wis.)

This is a high-school building designed for and built at Dodgeville, Wis., at a cost, as nearly as I recollect, of about $20,000.

Design No. 7. Dodgeville, Wis. Perspective.

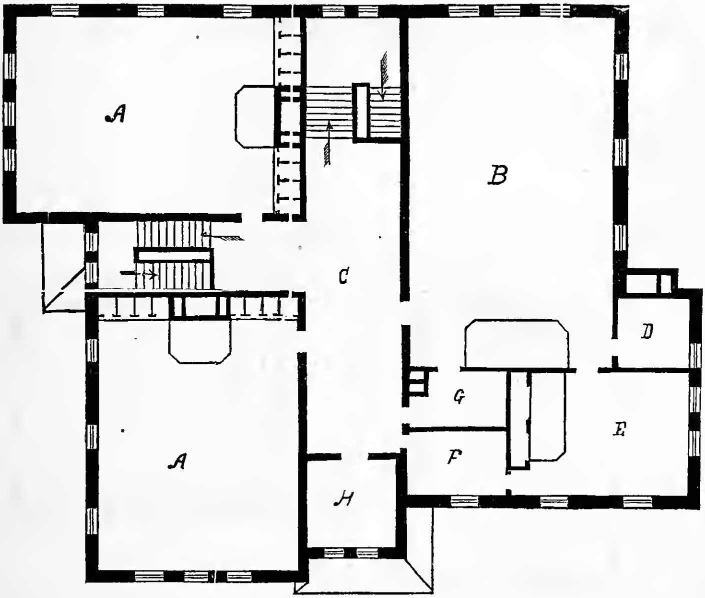
One peculiarity will be observed in the interior arrangement of this house, that the wardrobes, instead of being small rooms, as in most of the others, are simply a series of boxes on each side of the teacher's dais and the flue stacks, which boxes are about 2×2 feet square, made up with board partitions of narrow matched boards, at the back, overhead and underfoot, the floor being raised one step of about seven inches above the main floor. On each side and the back of



DESIGN No. 7. FIRST FLOOR.

these there are three to five strong iron "school house" hooks, on which the children hang their clothes. Each closet is about five and a half feet high, and covered with a neat panel door in front with proper fastenings. These closets are so situated as to be under the immediate control and view of teacher and scholars all the time, hence tramps and other outsiders cannot get in to steal the clothing, nor can there be much disorderly conduct among the vicious boys and girls, if there are such.

On the second floor there is the high-school room proper, B, which is considerably larger than the other rooms in the building, and off from and adjacent to this is a recitation room, E, and connected with them are the girls' dressing room, F, and boys' dressing room, G. There is also the room D for an apparatus room, museum, etc. The principal's office and teacher's retiring room is marked H. Together it is thought

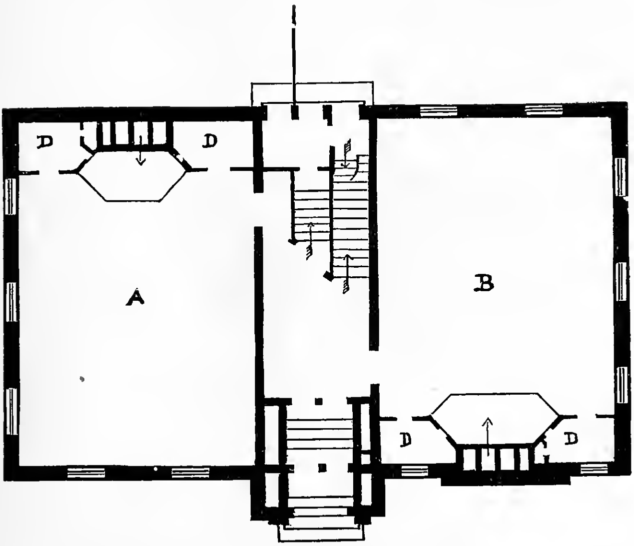


Design No. 7. Second Floor.

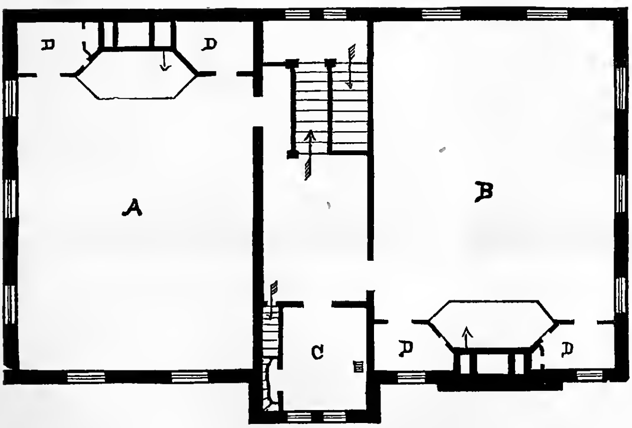
to be a very fine arrangement for the High School Department in a building like this, and worthy of being duplicated by others.

It has two flights of stairs from first to second floors, which are very easy, as are all stairs that I design for such buildings, making the "rise" generally six inches, while the "run," as it is called (the measure on the strings or horse), is seldom

DESIGN No. 8. (PROPHETSTOWN.) PERSPECTIVE.



DESIGN NO. 8. FIRST FLOOR.



DESIGN NO. 8. SECOND FLOOR.

less than twelve inches. Young scholars — girls in the years of their greatest danger to future health, or approaching their teens — can go up such stairs without injury, and aged people can get up such stairs with small effort, but this is a part of these buildings that seldom has the consideration due to its importance.

DESIGN No. 8. (Prophetstown.)

This is a four-room school house, two rooms above and two below. A glance at the plans will show that it has a central hall from the front to the back doors. At the rear it will be noticed that there are three outside doors, one of which opens to the cellar stairway for the special use of getting fuel and ashes in and out, etc. The short flight of stairs leads down to the outside doors, where the sexes divide and each goes to his or her back yard, which is divided by a board fence as shown.

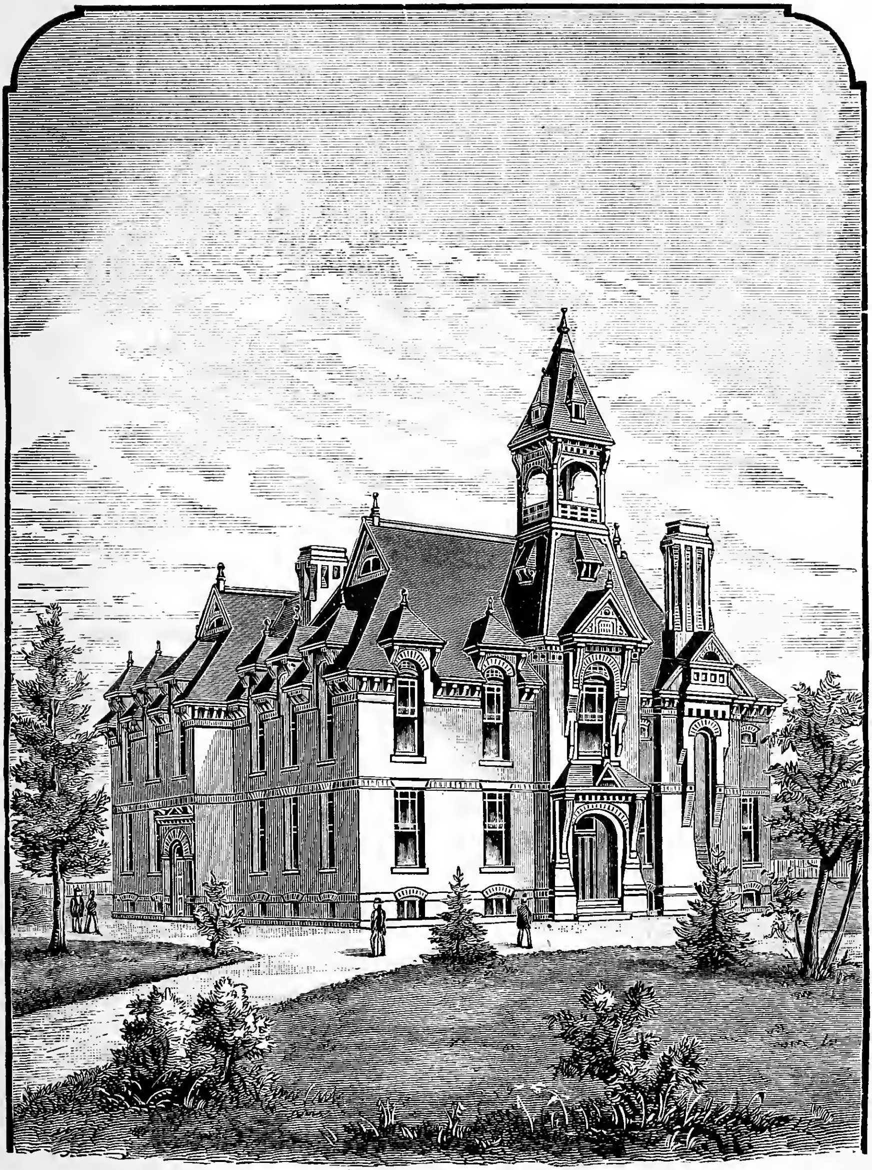
There is an attic stair by the side of the teacher's retiring or principal's room indicated by the letter C. D D are dressing rooms. This house was designed for a plain, tidy and inexpensive building, and its cost was not far from $10,000.

At first the contract was let with the bell, inside blinds and perhaps the concrete floor in cellar omitted, and for $7,800, but I think that after getting all these things in it came very nearly to $10,000; at least it ought to have cost that much. But it is a good house, and a very popular one with school men.

DESIGN No. 9. (Petersburg, Ill.)

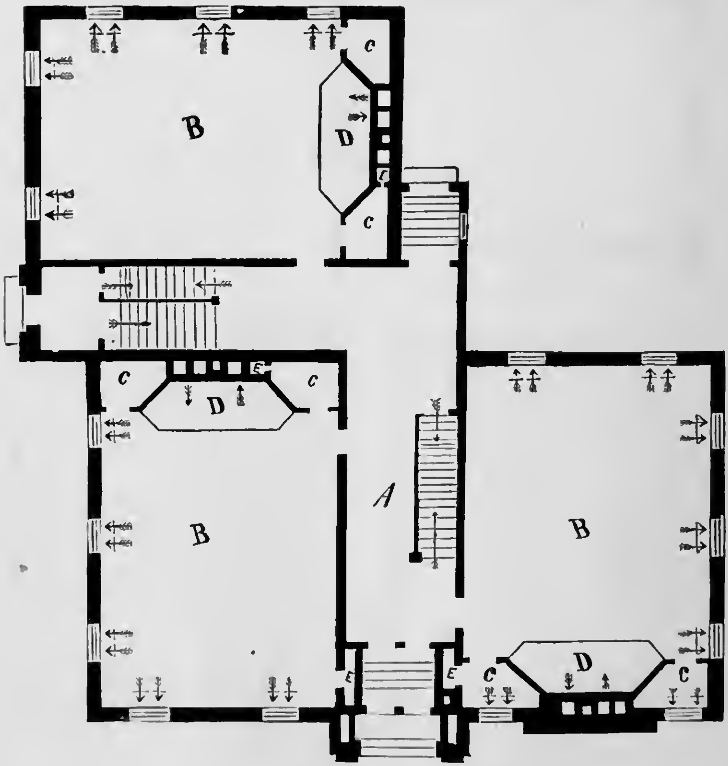
This is a design that can be built first with four rooms; secondly with six rooms, and, if still more are needed, two more rooms can be added in the vacant corner on the back side, thus starting with four and ending with an eight-room house. This manner of building in sections will especially fit the convenience of School Boards in a growing community, and where the *growing* propensity more than keeps pace with the finances.

As shown in the perspective elevation it is a very fine-



DESIGN No. 9. (PETERSBURG, ILL.) PERSPECTIVE.

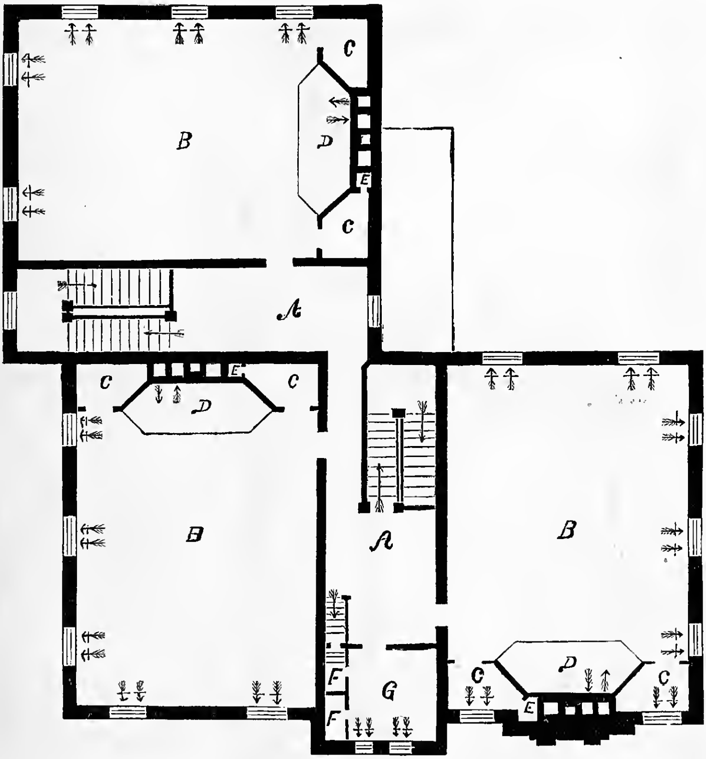
looking design, and moderately cheap. If a similar arrangement of plans, with a more simple exterior design, like No. 8, for instance, would suit better, it can be made. The object in cutting through the main cornice for the windows was to save expense of four or five feet of wall, and consequently a corresponding amount of waste room in the attic is saved by doing



Design No. 9. First Floor.

it, nevertheless the economy is not great because it increases the work in the roof. It, however, makes a more picturesque appearance outside. It can be worked either way in making plans for it.

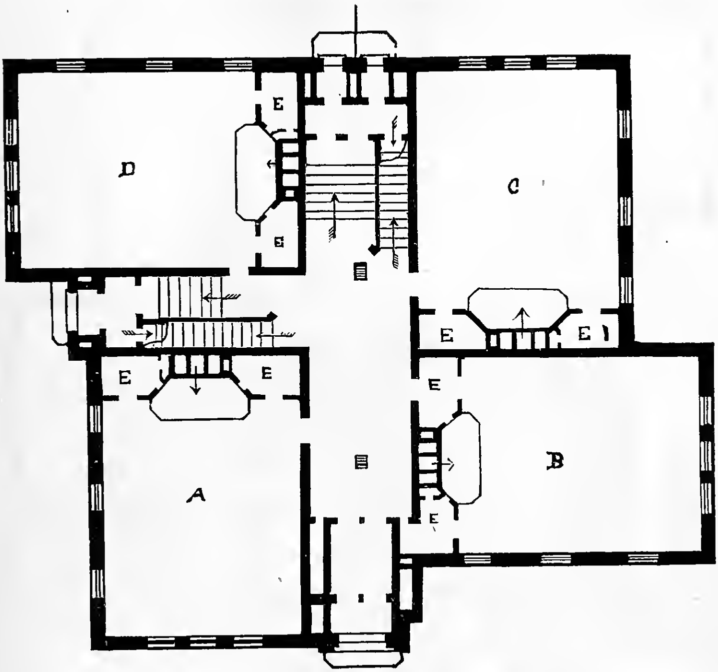
The main front east, with side entrance on the south, is the best as to frontage.



DESIGN No. 9. SECOND FLOOR.

DESIGN NO. 10. (MAYWOOD, ILL., not yet built.) PERSPECTIVE.

This is now building at Petersburg, Ill., as a four-room house, omitting the rear rooms, hall and stairway, so as to include just the simple parallelogram, for $11,600, exclusive of heating, which costs a little over $500 more. Had the six rooms been built it would have cost about $17,000.

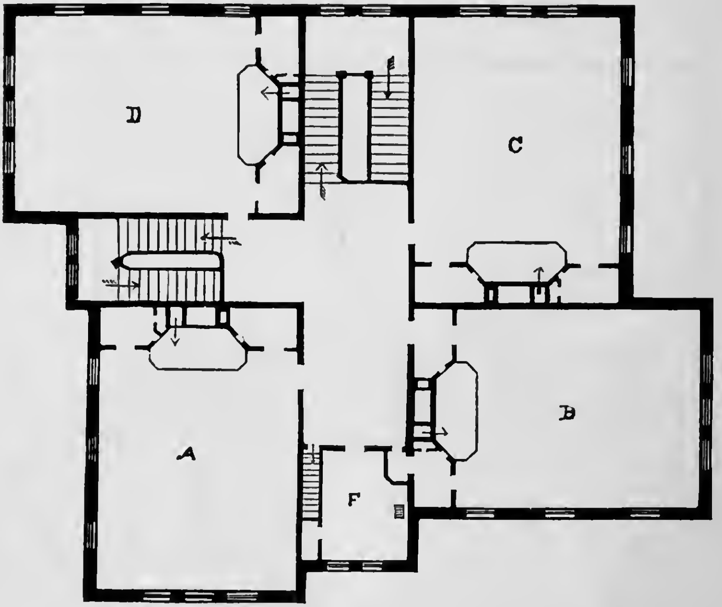


Design No. 10. First Floor.

C C are clothes closets. If liked better these closets can be small, like No. 7, or they can be like either of the others without any serious modification of the plans. For a good six-room house see Design No. 13.

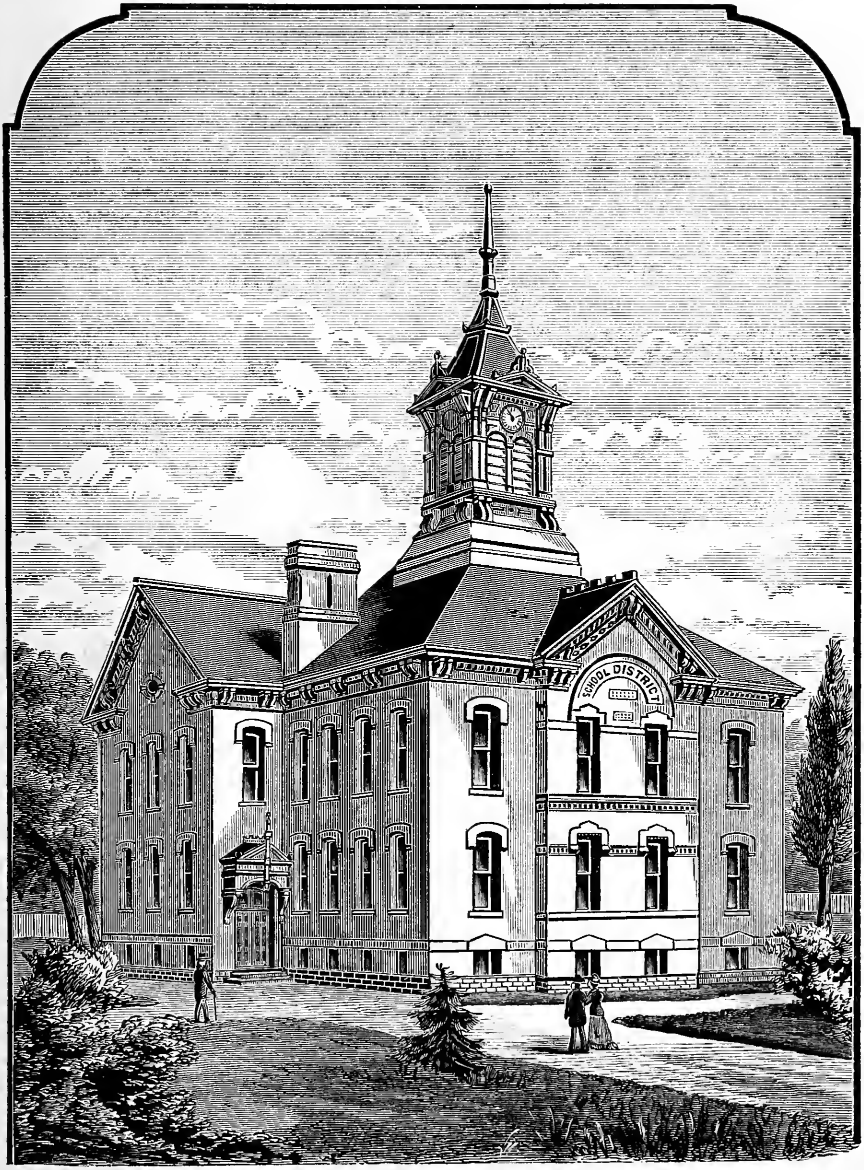
DESIGN No. 10. (Maywood.)

This is a design made in 1880, but has not yet been built. It is for a ward-school building, and though an excellent design it possesses no special points of interest over any other for an eight-room school house.



DESIGN No. 10. SECOND FLOOR.

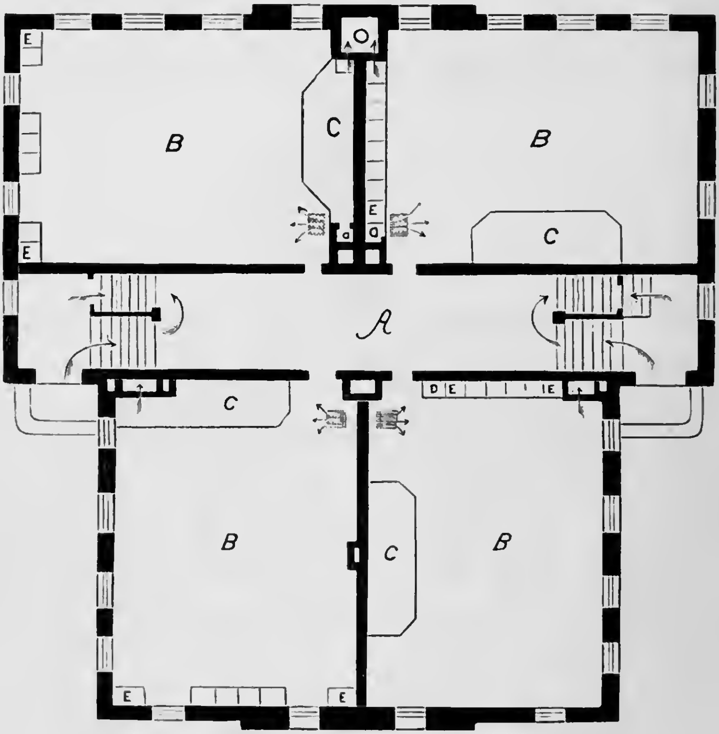
Its cost would not probably vary far from $20,000, $22,000 including heating and ventilation. It will be observed that its roof has a lower pitch than some of the others, but in this respect it loses in picturesqueness of effect when viewed externally. This, however, should not be a reason for condemning it, because in making drawings for it the roof could be raised. Generally the steep roofs are most admired.



DESIGN No. 11. (MENOMINEE, MICH.) PERSPECTIVE.

Design No. 11. (Menominee, Mich.)

This is a design that has been built at Menominee, Mich., and in a slightly modified form at Plymouth, Ind., and elsewhere. It is a design that was originally made without reference to placing the scholars so that the light would reach the



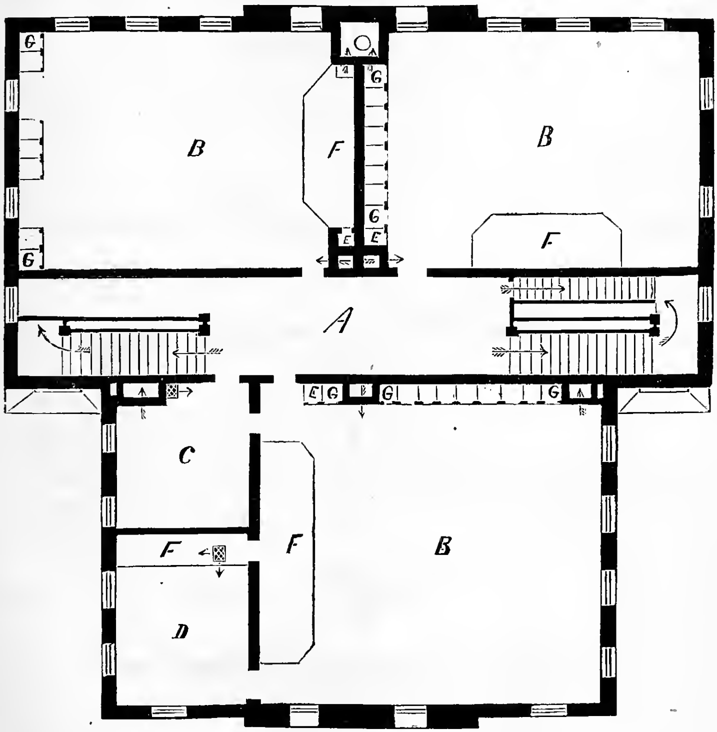
Design No. 11. First Floor.

scholars over the left shoulder. After this improvement had been discovered the teachers' daises were changed in this design so as to embody that improvement.

This is a high-school building as shown here, the high-school room being on the second floor on the south-east corner,

with a recitation room, D, and a principal's room, C, adjacent to it; these rooms, with the recitation room, are the equivalent of two ordinary school rooms.

This building is, however, different from others in this,—that it has its entrance doors on each side instead of in the center, the sexes dividing and going in and out at these two doors, with but few steps outside. Each door is covered with



DESIGN No. 11. SECOND FLOOR.

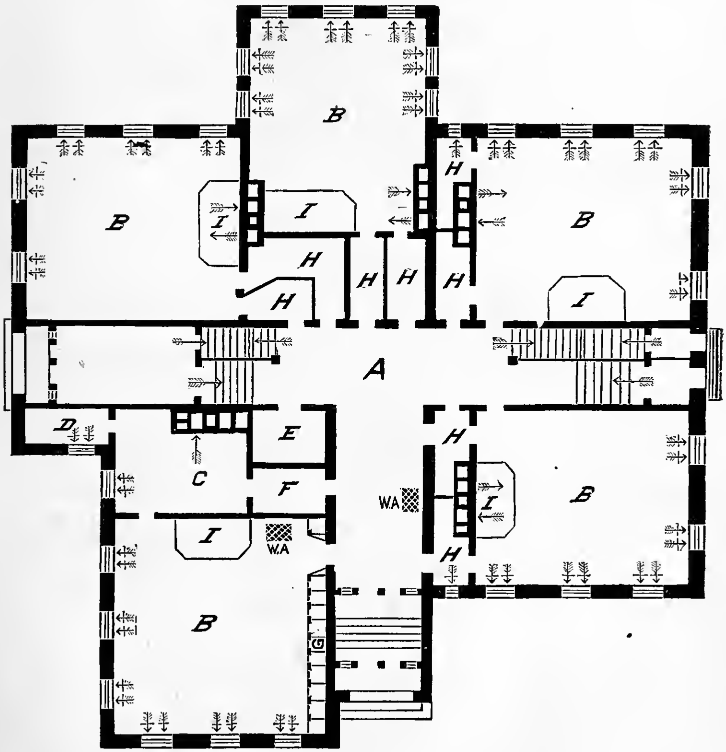
a canopy roof. In its ventilation the exhaust principle is first down to the cellar, then out of the building through the shaft in the rear. If I were going to build another I should change this to the flue stacks, as in most of the others.

DESIGN NO. 12. (RICHLAND CENTER, not built.) PERSPECTIVE.

This house cost, in 1860, about $15,000. Its cost at present would likely be nearer $20,000, but, I think, would not exceed this sûm.

DESIGN NO. 12.

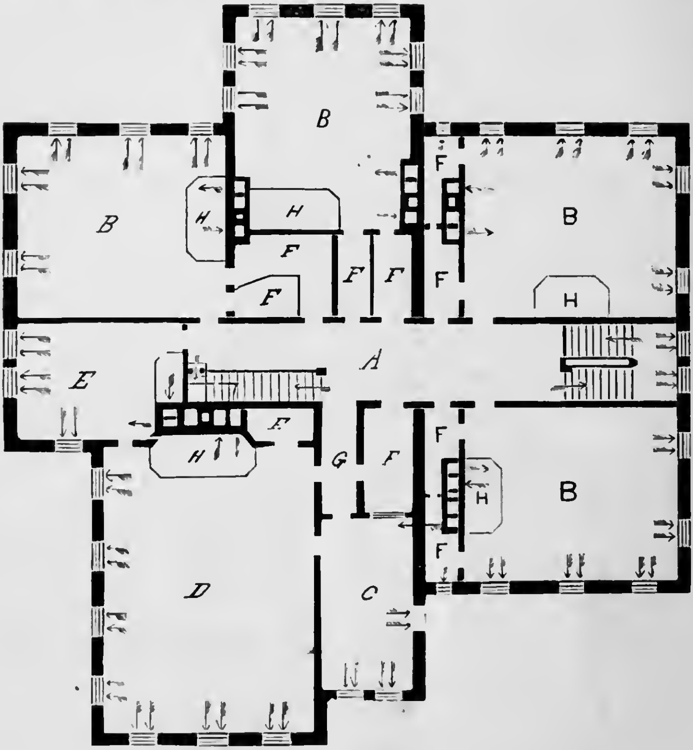
This design is for a house of ten rooms. It is especially adapted to the construction of a building at two different times, in this case six of the school rooms, including that for the high-



DESIGN NO. 12. FIRST FLOOR.

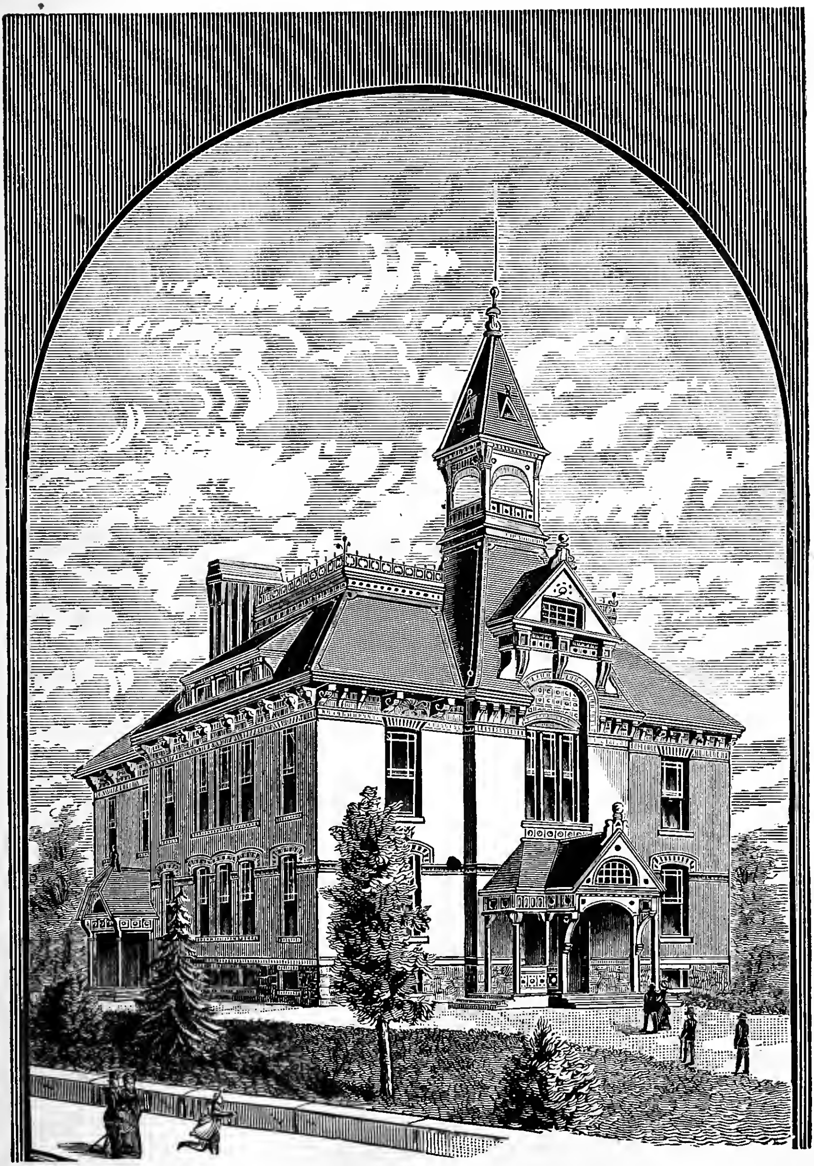
school room proper with its one or two recitation rooms off, or its one recitation room and principal's office, library, etc., may be built first, and the other four rooms, two on a floor, when they are needed. The building complete will generally cost

about $25,000, or the first six rooms for about $16,000 or $17,-000 and the last four for $9,000 or $10,000. It is about the equivalent of an eleven-room house, the high-school room with its recitation room off being the equivalent of two ordinary school rooms. These rooms are smaller than generally made, and are calculated for about forty-eight scholars at single desks.



DESIGN No. 12. SECOND FLOOR.

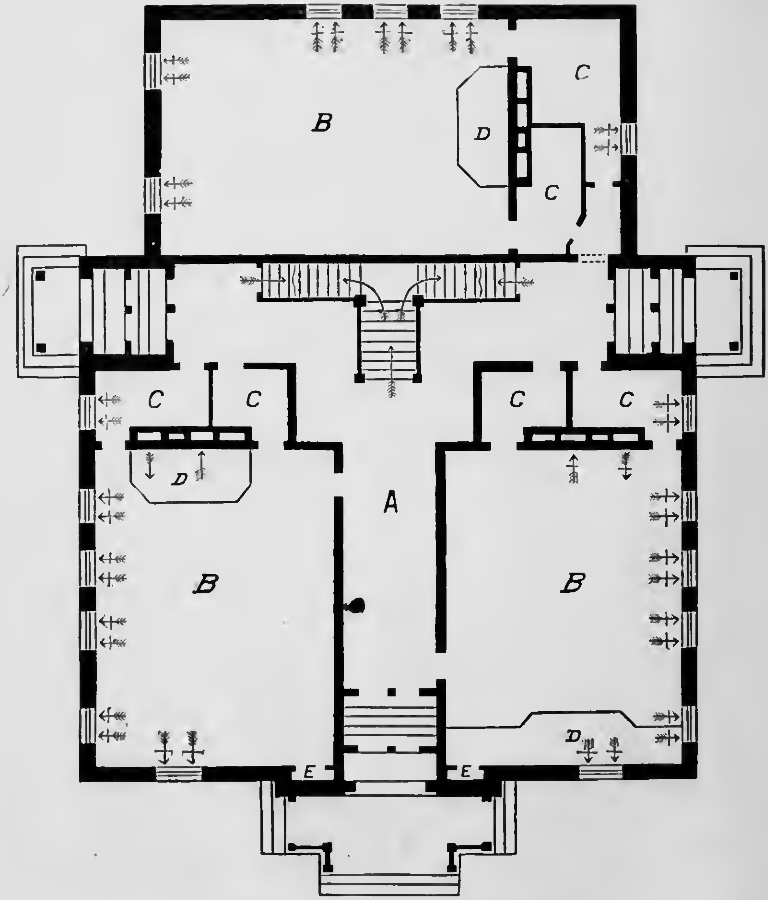
If seated at double desks the seating capacity would be about fifty-six scholars to a room. Any School Board which thinks well of this general arrangement can have it modified to suit, or the rooms increased in size as desired. The arrows on the floor plans show the direction and place of exit of the foul air as it passes out of the room through a perforated base under the floor and to the ventilating flues.



DESIGN NO. 13. (FERGUS FALLS.) PERSPECTIVE.

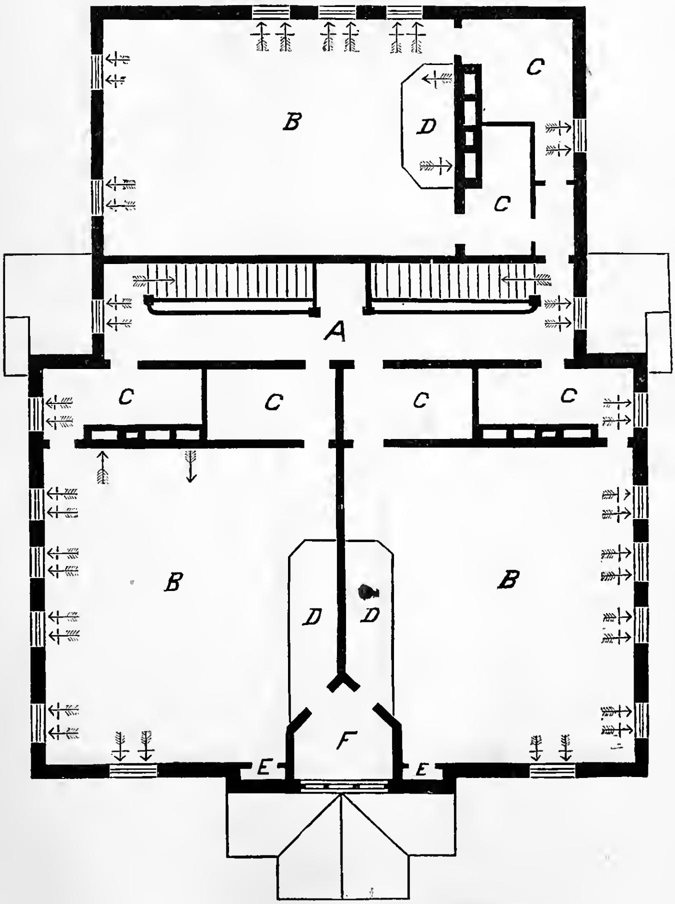
DESIGN NO. 13.

This design was made for a six-room house at Fergus Falls, Minnesota, where an eight-room house (see No. 14) was built from my designs last year. This I regard as one of the best designs for a six-room house that are contained in the book. There is one (No. 3) very similar in its interior appointments,



DESIGN NO. 13. FIRST FLOOR.

only that the main hall is two feet narrower than this one, and the dressing rooms are to be occupied by both sexes, while these have each a separate room for each sex, all nicely lighted and ventilated. Externally, this is a model in its design, but the exteriors may each be made to fit either design as preferred. This one, No. 13, is slightly plainer than the first, or No. 3, but will make the best building.

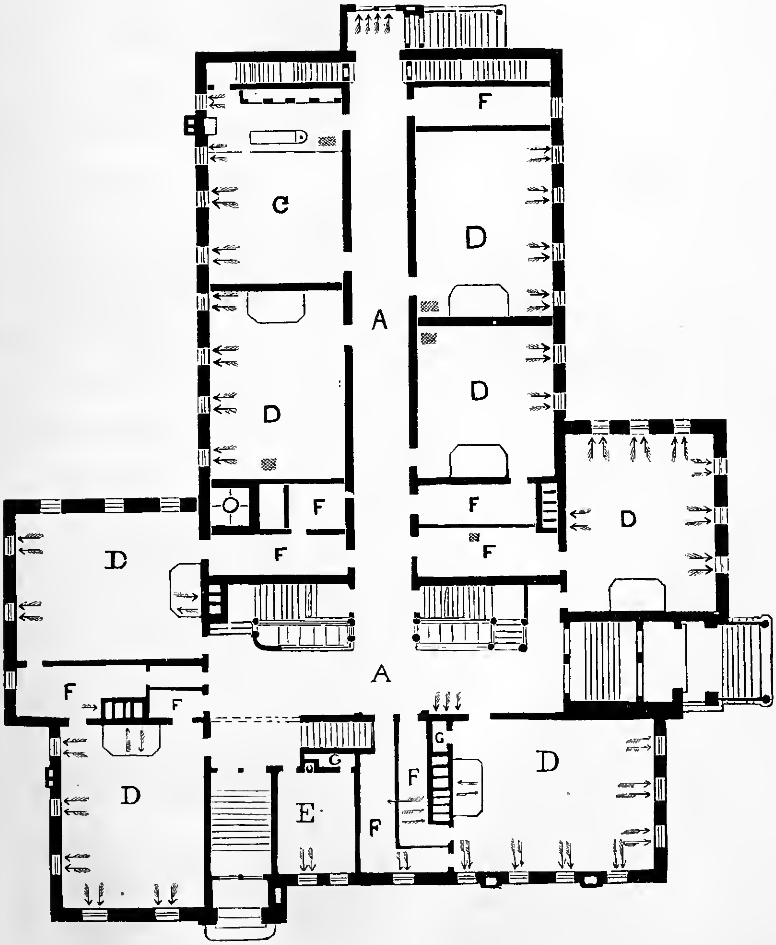


Design No. 13. Second Floor.

DESIGN No. 14. (ST. PAUL HIGH SCHOOL.) PERSPECTIVE.

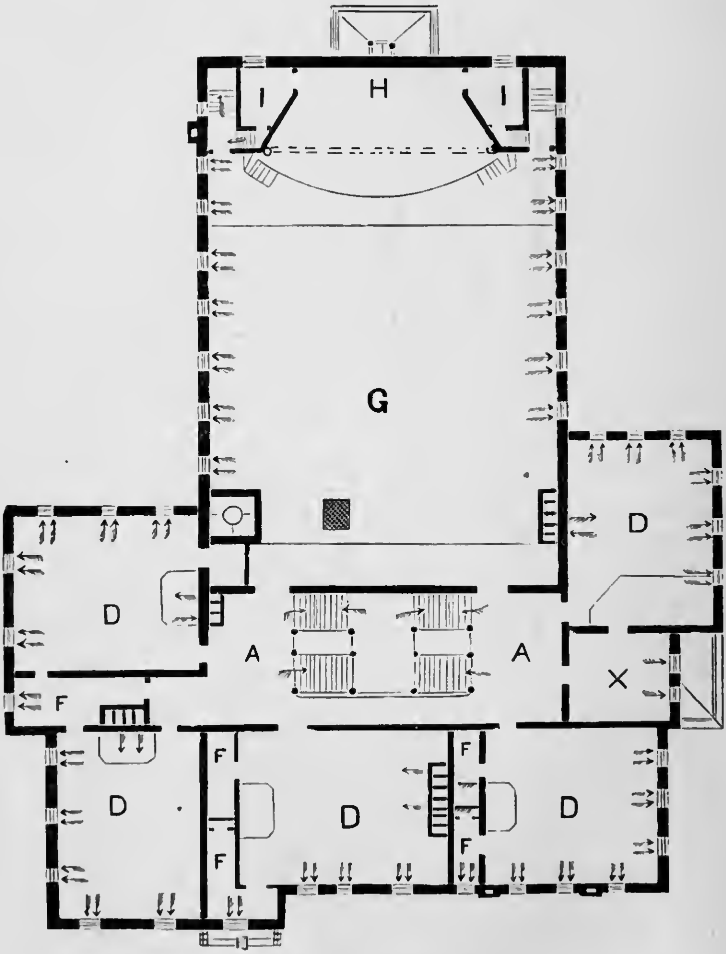
Design No. 14.

We will close this series of designs with two floor plans and a perspective view of the high-school building, designed by the writer, lately built and now about to be completed at and for the city of St. Paul, Minnesota. The floor plans here



Design No. 14. First Floor.

shown are the first, or main floor, and the second, or hall floor plans. In addition to these there is a large basement, in which there are offices for the clerk of the board, superintendent of public schools for the city, and a room for board meetings. These occupy the space at and near the part of the building



Design No. 14. Second Floor.

cornering on the two streets, while in another part are a suite of rooms for janitor and his family, for the heating boilers (steam), and water closets for pupils and teachers — both sexes. Beside these there are chemical experimenting rooms, etc., etc. All of these are in easy communication with the main floor and directly with outdoors by several passages and doorways. The main, or first floor (the one above the basement) has the principal's office, several ordinary school rooms and their usual appendages, also lecture rooms for chemistry and the sciences, except that for geometry and mathematics, which is on the second-story floor. On this latter floor also, are several school rooms, wardrobes, etc., and a notable feature of this story is its large lecture hall with its inclined floor, stage, etc. The reader will notice that at each end of the stage there is a stairway leading down to the corridor on the first floor whereby the sexes may reach the stage privately and where a lecturer may also reach his place quietly should the hall be crowded.

Another feature of this building is its immense stairway hall for getting to and from the lecture hall, which, with the two stairways direct to and from the stage, will give an assurance of security of egress in case of accident or fire.

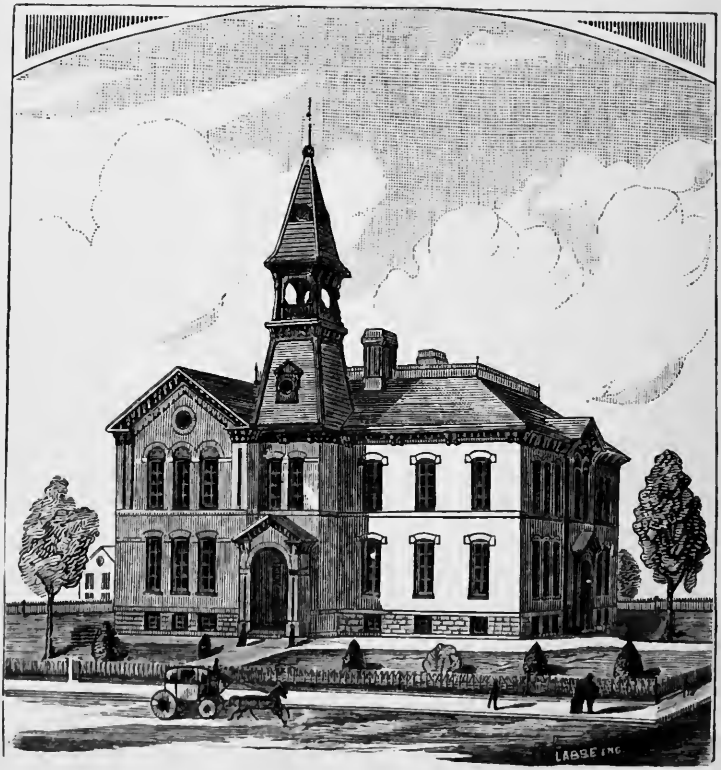
On the third floor there is a museum and library, and over the great lecture hall there is a large room finely lighted and ventilated and designed for gymnastic exercises.

The grand stairway hall goes up through the height of the building from the main floor and is covered with a large skylight which was designed to fill this part of the building with a flood of light.

In all its appointments it is one of the most complete and best high-school buildings that I have ever designed. It has been built under the immediate superintendance of D. W. Millard, a local architect, and if the HEATING and VENTILATION have been properly attended to and the design carried out as intended, it will be one of the best ventilated school buildings in the country.

DESIGN No. 15.

Is a design for an eight-room house built last year both at Fergus Falls, Minnesota, and at Escanaba, Michigan. It has seven rooms of the ordinary size, and one for the high school, a very large room, with a large recitation room off, and with wardrobes, principal's office, or retiring room, etc. Its cost at Escanaba was $21,000, and at Fergus Falls, where material, especially stone, was dear, it cost $24,000.



DESIGN No. 15. PERSPECTIVE.

FIRES! FIRES!!

HOW TO PREVENT THEM.

Since this book went into the hands of the printer, one short week ago, I have heard of no less than three school buildings that have been burned, owing no doubt to the faulty construction of the buildings and flues, and such fires are common every winter. As soon as we begin to have cold weather we begin to hear of school houses burned. This is the "trial by fire" we read of. I improve this opportunity to try to impress upon the minds of School Boards and officers what they do not seem to understand: that architects are not all alike capable of designing these buildings so as to avoid exposure to fire. I had been doing more or less of this work for twenty odd years before I hit upon a method that I considered complete security against fire, but now every house I design is so constructed that it is almost an impossibility for it to get on fire if built as designed; and here I want to say to each and every School Board that you cannot afford to take the chances of having your buildings burned, and children and teachers turned out of doors in a fright, for the sake of saving the small pittance it would cost to employ an EXPERIENCED and COMPETENT architect to supervise such work. It may seem egotistic in me to say it, but I have no doubt my services in superintending the construction of such a building are worth more than those of any half-dozen local architects or builders that you can get, and simply for the reason that I have done so much of it that I *know* just where to look for faulty or defective work, while a younger individual, who has had a more limited experience, would pass over and suppose it all right.

Almost every architect has his specialties, and if he excels in anything it is in some one of these specialties, for no man can be supposed to know everything.

If I have any specialty in anything it is, no doubt, in the matter of ventilating buildings, and as I have designed a great many hundred school buildings of all grades, large and small, and a great many churches, public halls, etc., and have spent a great deal of time in the last twenty-five years in studying the application of the Ruttan System of Ventilation to these buildings, I may be pardoned for thinking myself an expert in this branch of my business, whereas if you employ a new beginner, or a comparatively new man, there are fifty chances to one that he is now where I was twenty to twenty-five years ago. I have made it a special study to devise some way to attach a furnace to the heating flues, or the heating flues to the furnace, in such a manner as to leave no chance for the surrounding woodwork to get on fire, and I think I have succeeded admirably. An inspection of the floor plans on these pages, with this explanation, will indicate substantially how I do it. Adjacent to each school room, and generally behind the teacher's dais, is set a stack of flues, in which stack there is a smoke flue, flues for ventilation and for the passage of the hot air up to the room to be heated and ventilated. Then I set the furnace, generally with one side flat against these flues, in the basement. The hot air passes from the furnace, which is inclosed in brick walls, to the hot-air flues, up which it goes direct to the room to be heated. The ventilation or foul air is taken out of the room under the floor, and the foul air goes directly up the ventilating flues to the open air above the building.

In this way there are no metallic pipes, and no contact with woodwork of any kind that can possibly expose the building to fire. Hence, if properly built, it may reasonably be pronounced absolutely safe from fire.

The best parts of the skill in ventilating one of these buildings is in knowing how to construct the valves and other accessories connected with the hot-air and ventilation flues.

These are all covered by letters patent and by copyright, so that no one can use them without my permission.

It will readily be seen that a building so constructed is absolutely secure against danger from fire, but to know that a building is so constructed, it must have an occasional inspection by an expert.

If I have an order for plans I arrange all these matters to meet the necessities of the case, for they are not necessarily all alike, but with a building properly designed, and all these flues and their details properly constructed, this ventilation will work like "clock-work," with little or no danger from fire, and none at all if carefully and properly built. To get the benefit of my twenty-five years of constant study and observation of these things, it will be necessary that you have me design your building. To get somebody else to copy my designs elsewhere or from my books is only to attempt to get from me in a clandestine way that which is mine, and you take the risk of having eventually to "render unto Cæsar," etc.

I am fully aware that a large proportion of the school buildings that are built are more or less patterned after my designs, so far as their authors have got posted, especially as regards heating and ventilation, for, though I make the ventilation substantially after the Ruttan principle, yet it is the Ruttan *improved*, for, with all due respect to the memory of the late Hon. Henry Ruttan and his system of ventilation, as he left it, it would not be tolerated at the present time ; still he left too much that is good to have it ignored altogether, or to call it after any other name, and yet the most valuable details connected with his system are of my designing. In saying this I have no reference to the mode of heating. Any method of heating is good that will furnish a sufficiency of heat with a sufficient amount or volume of fresh air. This Mr. Ruttan could not do with any heater that he had devised, and his successors, the present Ruttan companies, out of pure necessity, devised a furnace for the special use of heating public build-

ings, and their furnaces will heat a school house and ventilate it if a suitable number, or those of suitable size, are used.

Seeing that I have set up so large a claim to what is known as Ruttan ventilation as applied to school buildings, it may be well for me to say that I claim nothing in regard to the several designs as specimens of *architectural* designing. The pictures in these pages are (the most of them) of buildings already built, and were designed to suit the fancy of those for whom they were made, and, while they may be good enough, they are not supposed to be any better than any other architect's clerks can make with the same opportunity and means. They are greatly inferior to what *might* be made with unlimited means, and generally these several designs are selected because of their inexpensiveness and adaptability for the greatest good to the greatest number.

In conclusion I will say that, for buildings far away from my place of business, I can furnish the drawings with the Ruttan system of ventilation, with the improvements which I have from time to time devised, and I will make them so plain that a good mechanic will understand them perfectly, or the details and specifications will be understood by any member of the board, and if they, on account of distance, cannot afford to pay me for taking the responsibility of a full general superintendence, instead of the commission for a general superintendence I will make one journey for a final inspection of the building, at which time and place it is probable that I can ascertain if everything is all right, and the building secure from fires. Much the *best* time, however, for securing the latter object would be when the furnaces were being set. At this time everything would be uncovered and exposed, and if not all right it would be in a better condition to be corrected than at any other time. This would cost, beside the fee for plans, traveling expenses to and from and a moderate fee *per diem* for time spent.

APPENDIX.

It was my intention when I commenced this book to devote it entirely to School Architecture, but having been disappointed in getting engravings of some of my large buildings such as colleges, etc., ready in time for the printer, I shall have to substitute a few cuts of other buildings which I have on hand and ready, and which will be found hereinafter in their order.

In offering my services for the construction of larger and consequently heavier buildings, it may be well that I should make some further suggestions in regard to my knowledge of construction and my past experience in this city and the surrounding country.

When I commenced business, about twenty-seven years ago, the soil then was quite unlike what it is at the present time. There were comparatively but a small number of sewers and drains, and the city was down several feet lower than at the present time.

Then it was not an unusual circumstance in putting up a block of stores to have to make foundations in a bed of liquid quicksand, and I well recollect of building three stores on State near Van Buren street, where the quicksands were so thoroughly liquefied that it was only practicable to get the trenches for front walls by dipping out the quicksands and water at the same time, with buckets or water pails. Such a condition of things would be the worst for getting a good foundation that can be imagined, and yet, with these disadvantages, to the surprise of my client I put up his building without a flaw or crack in the front that was visible to the naked eye.

I had done a good deal of this kind of work in the East on railroads and elsewhere, and *always* with complete and unvarying success. I have always used concrete for such soft soils as was then, or is even now, in this city and elsewhere on these western prairies, and never feel secure and certain of complete success when this important material is omitted.

The old architects here, apparently, knew little or nothing about its value or use, and for fifteen years, or down nearly to the time of the great fire, they used large dimension stone at the bottom as the best foundation *they* could make and ignored. concrete altogether. The then citizens of Chicago will not fail to recollect the Unitarian Church built on Wabash Avenue, the stone tower in the front of which, with the front, settled so badly that it had to be taken down. They then thought to save it by driving piles, but after piling it and rebuilding on them, it still went down, the tower going twenty inches, or two feet, into the mud and quicksand, and finally to save the stone they took down the tower a second time and rebuilt the church without it. Other churches were building near by, the First Baptist for instance, the front of which settled and the walls cracked and opened on the sides back about thirty feet from the front so that a man's arm might be laid into it. All this and the settling of the tower of the Unitarian Church was for the want of a proper foundation of concrete. They should not have settled at all, or comparatively little, if any. The files of the Chicago *Tribune* of that date indicate clearly who it was that did NOT know how to build good foundations then, though the same parties have learned something since, and the ground, through the system of sewers and drains, has become entirely less difficult to build upon than in those early days. On the same street with the buildings before named, the writer laid the foundations, broad and deep, of what was when built, a Congregational Church, but after the great fire it was sold to the Catholics, and has since been known as St. Mary's Church. Nearly every building built by the writer, especially if it was a large building, had foundations of concrete, and I seldom or never had any trouble with buildings settling; while up to

twelve or fifteen years ago, and with some of them till a much later period, the old architects who were and still are my contemporaries here, have ignored it to the disadvantage of themselves and clients. At the present time, however, there is seldom a good building put up by anybody that does not have a concrete base. I dwell on these facts for the purpose of reminding the public, and those of them who were not here in early days, that in some of the most important improvements in building the writer has taken a decided lead.

In the selection of an architect it is of much greater importance to find one whose record is good in all such things as an unprofessional man is not supposed or not likely to understand, while in the mere matter of architecture every man thinks at least that he has the qualification of a critic, and that he can judge of his architect's production in this respect when laid before him. This is undoubtedly true, at least to a limited extent, and admitting it to be so, every individual who is going to build an expensive building in which he does not care to have any vital failure, should see to it that he gets an architect in whose skill in this respect he has confidence, and if need be he can take the chances of judging for himself of the practical and artistic part of his productions when they are submitted for his inspection, but it is not an uncommon thing for a business man to be entirely misled and deceived by having a fancy picture paraded before his gaze when as a building its construction is entirely faulty and impracticable.

In architecture as in almost every other profession or business there are always those whose chief capital in trade is "cheek," and on the principle that "Doctors know each other better than other people know them," so it is with architects, and if other people knew some of them as well as some of them know the balance of the lot, there would be a very different dispensation of favors from what there now is.

I respectfully invite all, whether in the city or country, if they have grounds that they want to improve to give me the size of lot and its surroundings and let me give them a study or sketch. Then if it does not suit they can try some one else.

They will have incurred no expense by giving me the FIRST trial.

There is still another important item which should always be taken into account in the selection of an architect, and that is his

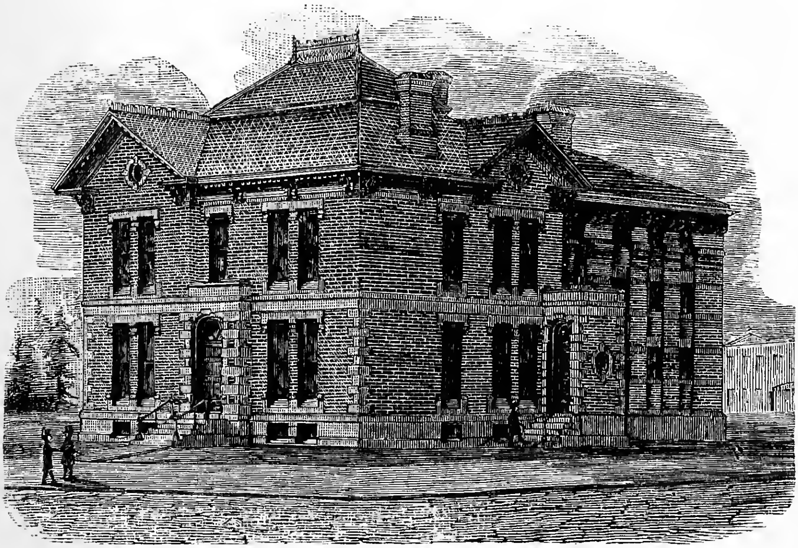
INTEGRITY.

I have lived in this city long enough to have established a reputation either for integrity or the want of it, and I appeal to my neighbors and friends, or enemies, if I have any, and more especially to the best builders of Chicago, who have known me well, since a resident here, to say if to their knowledge I have ever in the least degree been under a cloud, and I challenge one and all of the less reputable class of builders or tradesmen to say that I ever to their knowledge in my professional practice departed in the least degree from the path of rectitude.

I know there are those whose records are not clean in this respect, but there is not a man in Chicago who can truthfully say that mine is one of them, or who dare say that he ever paid me money or its equivalent for the purpose of influencing my action professionally or otherwise, in any respect. I get as nearly the proper and established commission for everything I do as circumstances will permit, but never take commission or fees from my clients at rates lower than I can afford to do their work, and then supplement them by taking fees from, or by collusion with, contractors as against my client's interest, nor do they often offer or propose such collusion. Such approaches, if made, are usually from strangers.

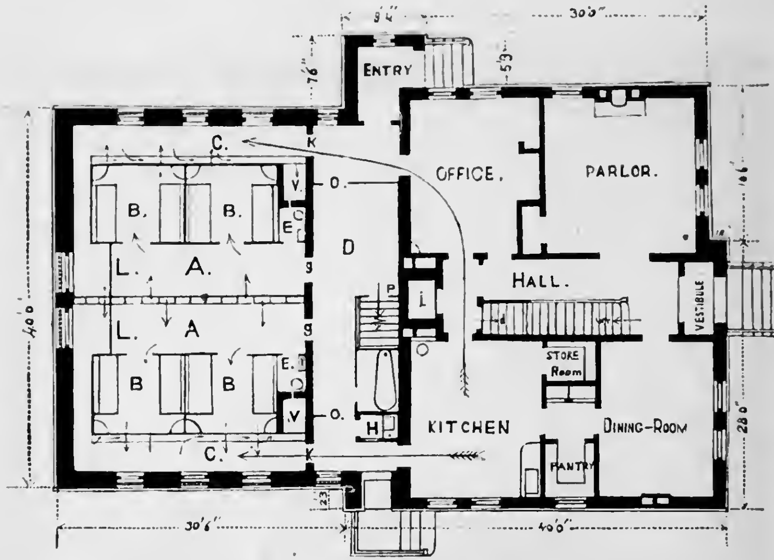
MISCELLANEOUS DESIGNS.

The first of this series of designs, A, is a cut of the exterior of La Salle county jail, Ottawa, Illinois. Cuts B and C, are, respectively, of the first and second floors of this



A

jail. The third floor of the prison is also a duplicate of its second floor. The building might be improved somewhat, were it to be built again, though it is in the main a very perfect jail building. Its cost was about $27,000 or $28,000.


ENTRY
OFFICE.
PARLOR.
HALL.
VESTIBULE
STORE Room
KITCHEN
DINING-ROOM
PANTRY
D
B. B. B B
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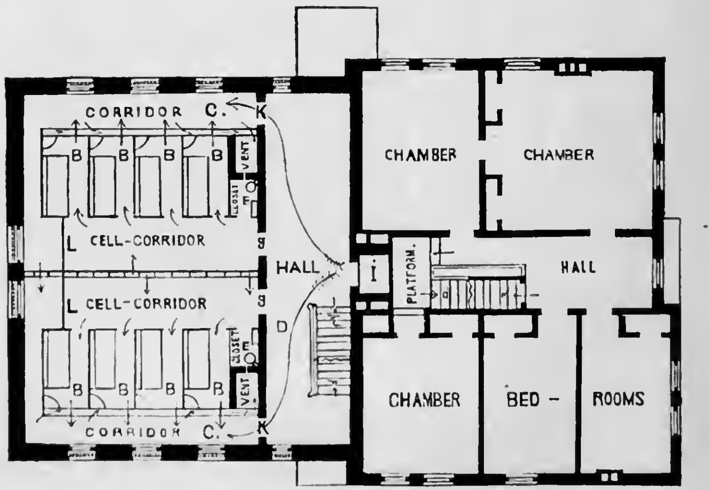
K K
P
H
30'6"
40'0"

B


CORRIDOR
CELL-CORRIDOR
CELL-CORRIDOR
CORRIDOR
HALL
VENT
CLOSET
PLATFORM.
CHAMBER
CHAMBER
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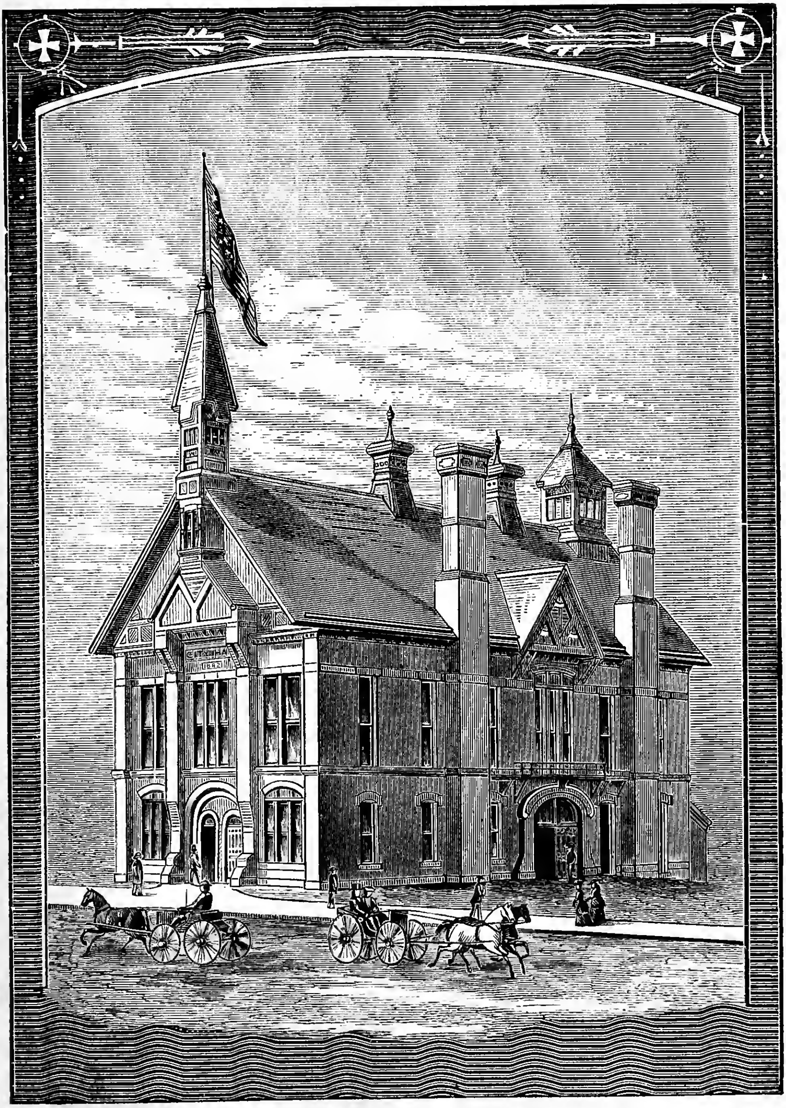
D

C



D

PLATTEVILLE CITY HALL.

The cut D is the City Hall at Platteville, Wisconsin.

This building is 50×100 feet, and has a basement, first and second stories and a gallery in the hall above the second floor. In the basement is the heating and ventilating apparatus. The ground at the rear of the building is several feet lower than at the front, and has two or three rooms for fire engines and apparatus, each of which is entered at the rear.

On the main or first floor, at the front, are two offices for city clerk and attorney, respectively. Then there is a city or municipal court room, and back of these a jury room, ticket office and dressing rooms, main entrance hall, stairway, etc.

On the second floor there is a large hall with gallery on three sides, and stage on the fourth, designed for social parties, lectures, operas, etc.

S. M. STEPHENSON HOTEL.

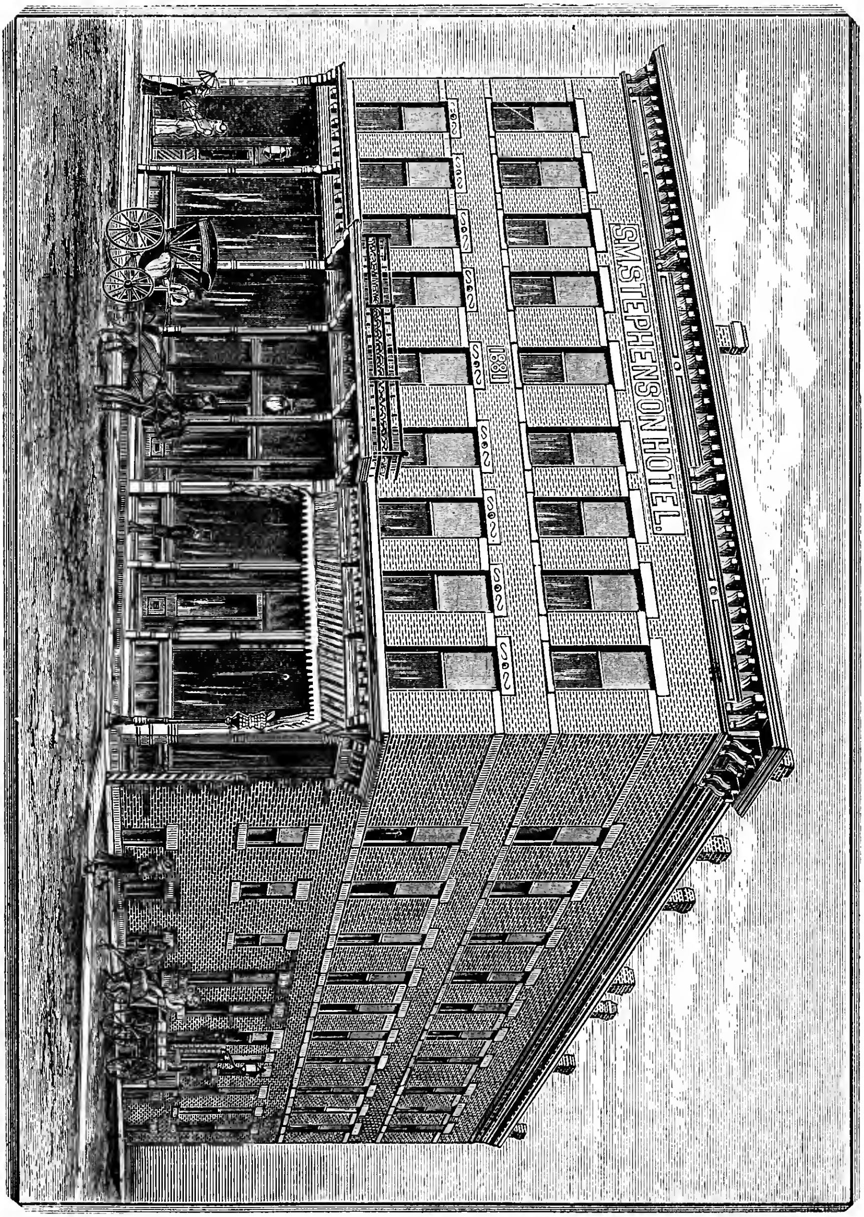
The next in order is cut E, or the S. M. Stephenson Hotel, at Menominee, Michigan. This is a substantial brick building of about fifty rooms, contained in three stories and a cellar. It fronts on Main street with its back side toward the bay or lake, from the rear of which are suspended galleries where guests may enjoy the lake breezes in the hot weather of summer.

This hotel, though not large, has been pronounced by travelers a "gem." It is provided with the modern improvements of a first class hotel, such as bath rooms and water closets, ample in number, has good drainage, gas, is heated by steam, etc.

The office has its floor laid of marble tiles, including the porches in front, and is some seventy-five feet deep.

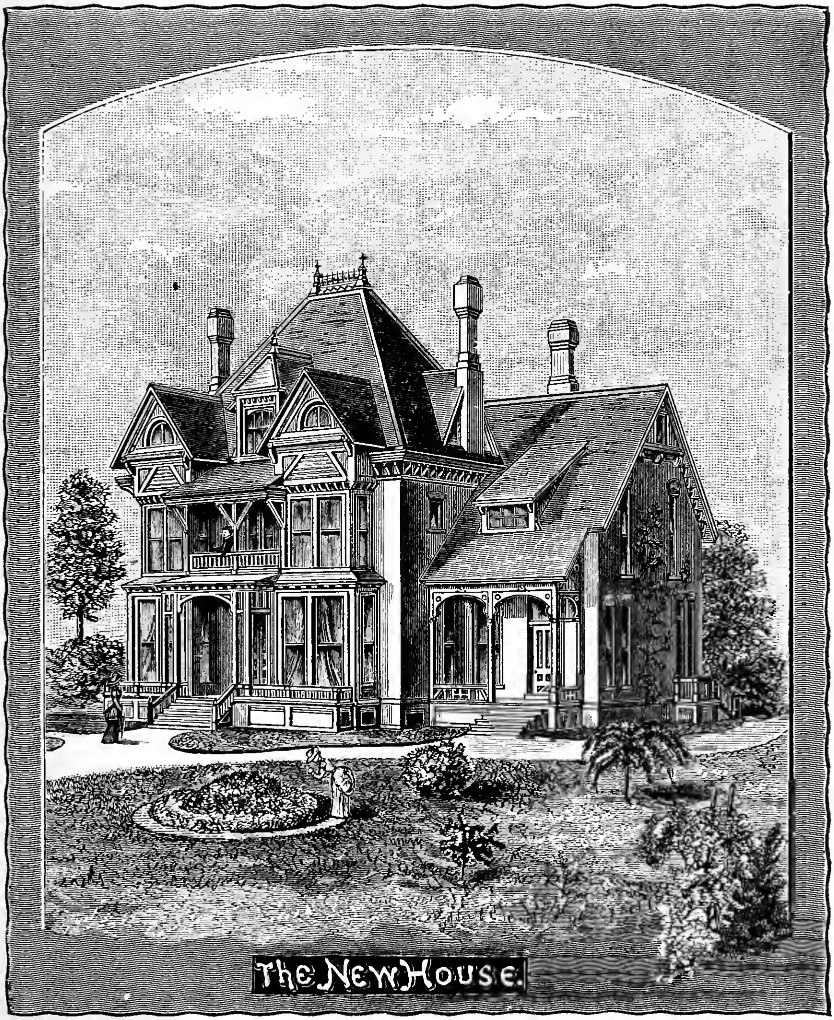
At the rear of the office is a very fine dining room that overlooks the bay, which, at this point, is some twenty miles wide. Though plain in its exterior it is nevertheless a first-class country hotel in all its appointments.

E.

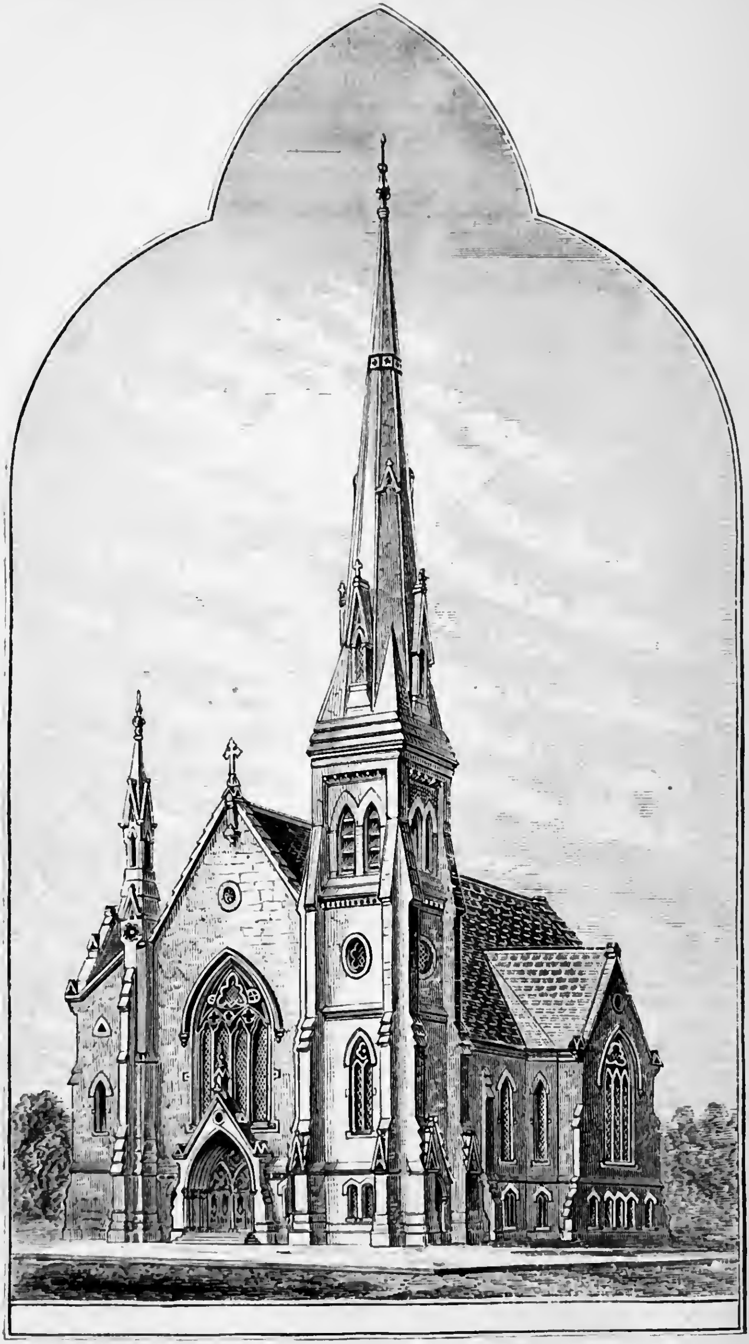


We give as next in order of these miscellaneous cuts the late residence of the Hon. Reuben Elwood, member of congress from the Fifth Representative District, Sycamore, Illinois, as it was some three years ago (see cut F), and in design G the same residence after having been transformed into a more modern building, with some additions, etc. By this transformation we may see what a unique and pleasing building can be made of an ugly, uncomely old one, by a sufficient application of brains and ducats.

F



G



D

CHURCHES.

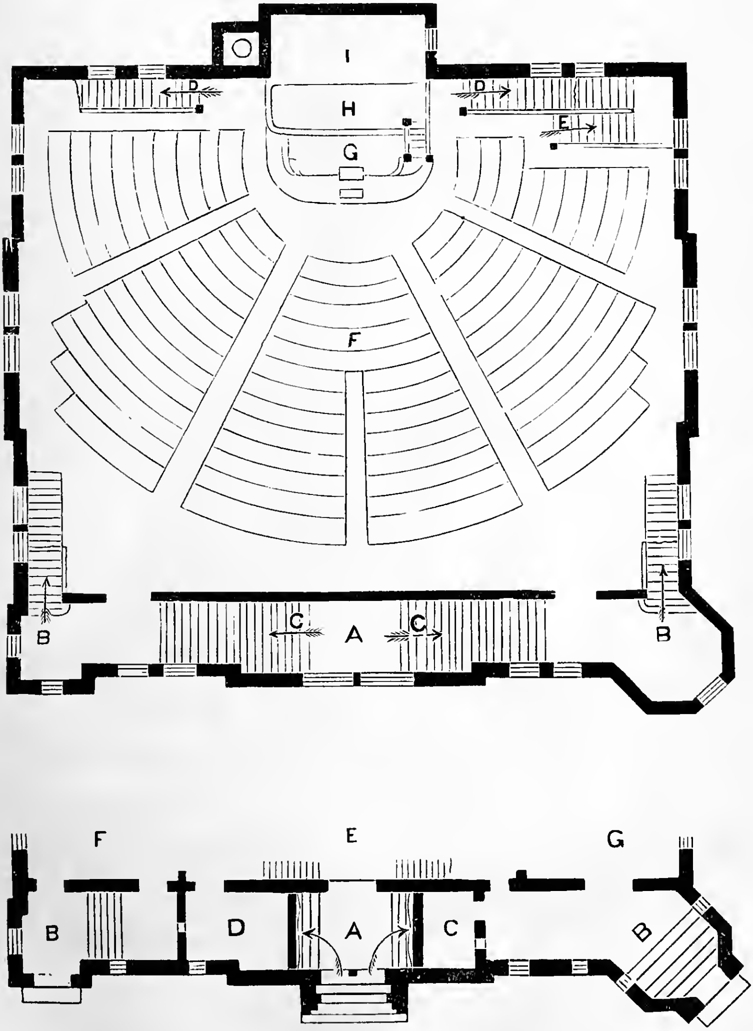
As I have already observed elsewhere (pages 5 and 6), I have heretofore designed a great number of churches, several of which are the best in this part of the country, and I give in these pages several cuts of these buildings. The first in order is the Union Park Congregational Church, on the corner of Washington Boulevard and Ashland Avenue, and fronting directly on Union Park, in this city. (See design D.) This is now one of the oldest of our first-class churches, and is chiefly noticeable for its lofty spire (250 feet), and for its having been the first amphitheater church in its full development, and with a bowled floor, ever built in this country. It has its counterpart in the Church of the Universalist Society of Minneapolis, Minnesota, which was built more recently, and again in the Church of the First Congregational Society, Mansfield, Ohio, and still again in that of the First Baptist Society, Grand Rapids, Michigan, and elsewhere in a more varied form, as the Congregational Church at Madison, Wisconsin, and many others.

I have found in practice that the style of seating in design H (see floor plans I and J) is best obtained when the body of building takes about the form of a square, and a larger audience can be more comfortably seated in a house having these relative dimensions than in most others.

A very large gallery may be advantageously constructed in such a house. See floor plan I and outside door and entrances to basement plan J, where A and A' are the vestibules, main entrance and stairs, while B B on main floor are stairs to the gallery.

H

It is to be regretted that we have to go to press without a gallery plan. It will be observed that these gallery stairs, B B, open on to a large spacious landing, or on a level of the main floor, thus giving ample space for the audience from



I & J

the gallery to mix with that below, before going down the main stairs.

At the rear of the building, in each of the corners, are spacious flights of stairs that lead down to the basement, and thence to the streets, by which means both ingress and egress are made ample.

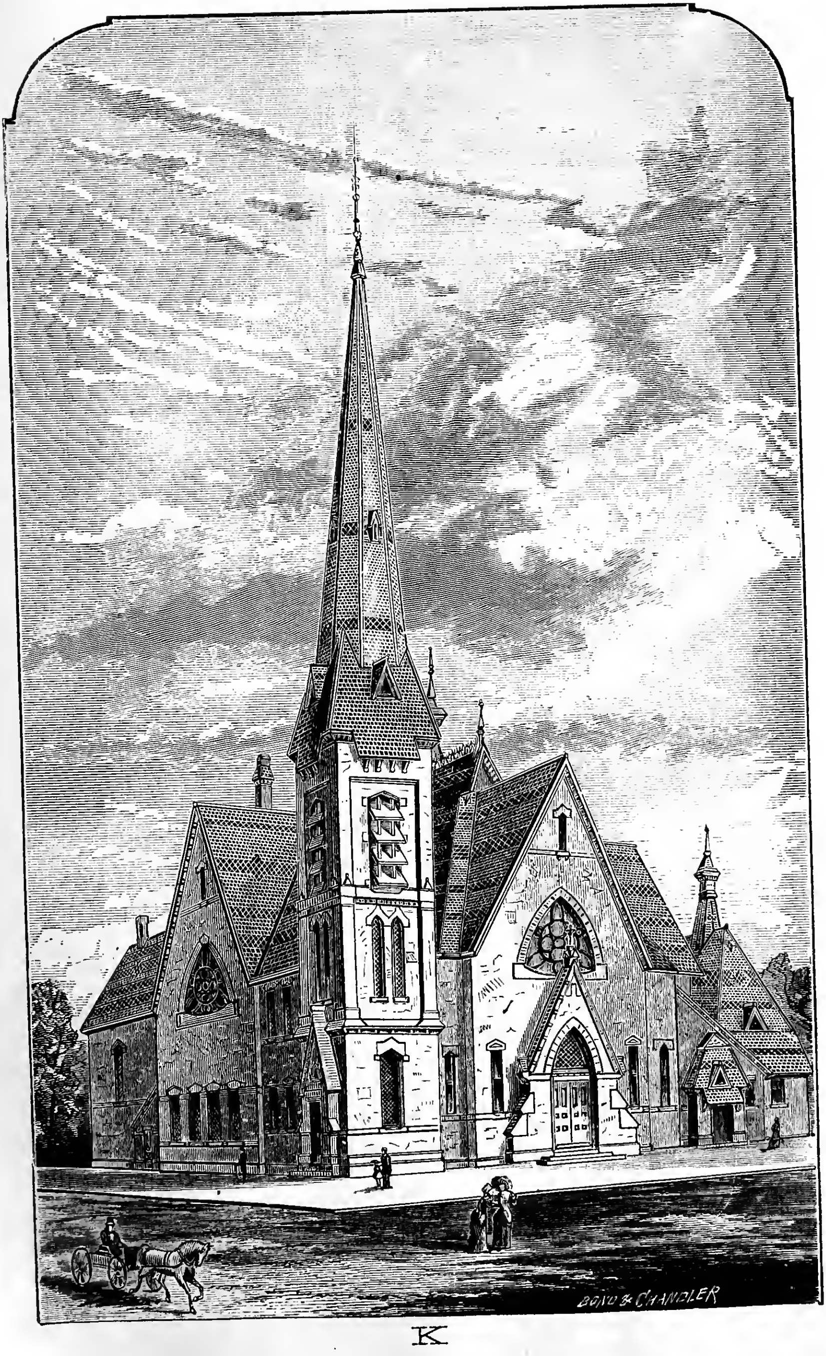
But a small portion of the basement floor—that next the front—is shown in these cuts. E, G, F are working rooms, E being the main Sunday-school room and lecture room; G, a ladies' parlor and waiting room; F, infant class room; D, Sunday-school library; C, clothes closet, etc. In this case the frontages are east and south, but in this respect the plans can be modified to suit circumstances.

The exterior design H, indicates a square, each side being about the same length. The roof is in pyramidal form, with like inclination on each of the four sides, and these are relieved by steep gable and otherwise.

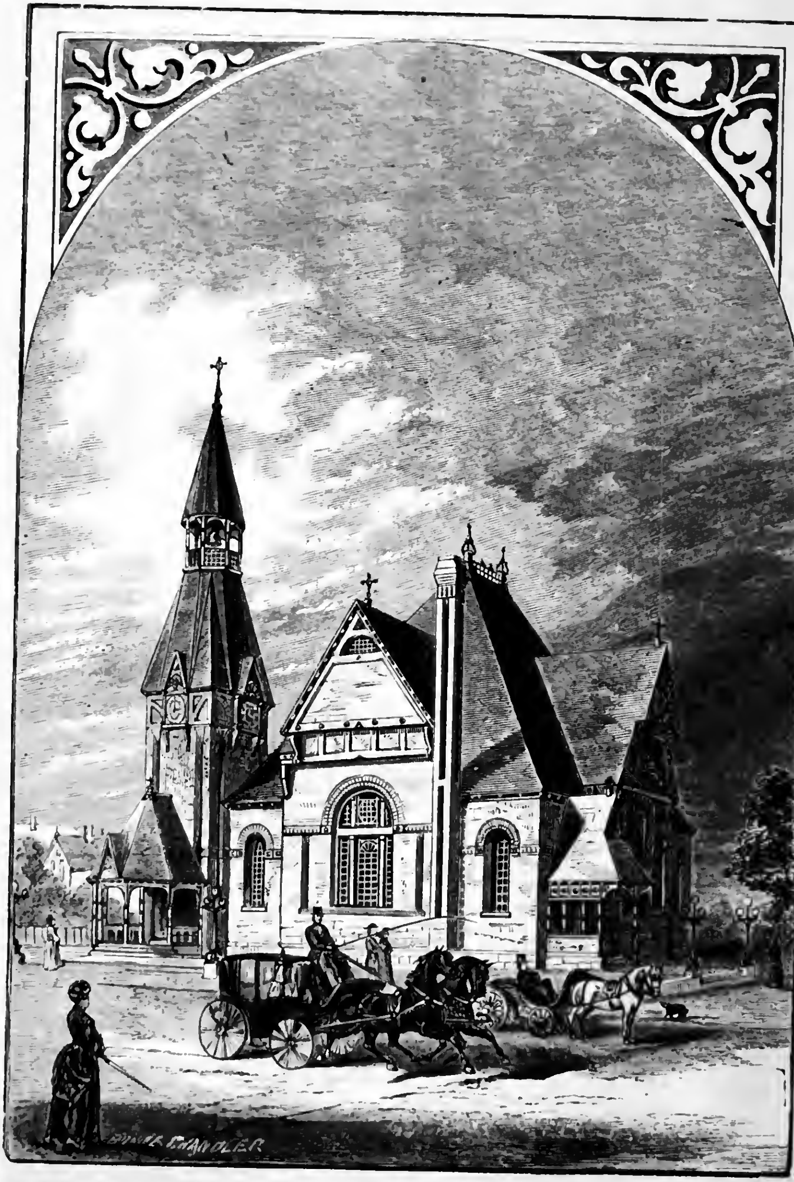
This is a very cheap and strong form for a roof covering such a building. No roof containing so small an amount of timber can be devised that will be so absolutely strong and unyielding as this one. Then again, it admits of a flat, plain ceiling, or a ceiling with all the ornamentation the congregation is willing to pay for; or it may take any form the skill and taste of the architect may devise. In these several points it has no equal.

A small, cheap building of the kind has been built in this city in the last two years, and it is considered by every one a complete success. It is the uniting of a *minimum* of material with a *maximum* of skill and constructive genius, and the result is the best construction that can be conceived, and the least cost, and it is the same, whether applied to a cathedral or "the little church around the corner."

K is a design for a church at Fargo, Dakota Territory, but is not yet built. It has no basement, but only a cellar for heating apparatus — may have a gallery, or otherwise, and is to have its Sunday-school room on one side, and outside of the main building, to which it may be made a part of the audito-

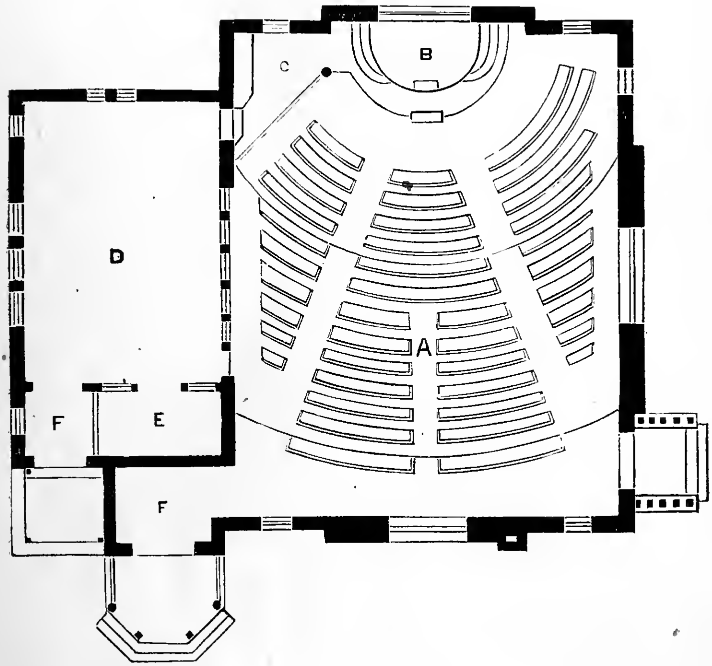


K



L

rium when the latter shall be full. Some of the rooms for social purposes can very well be located in the attic of the pyramidal roof that covers this part of the building. Church trustees that want to build such a construction as this, can have a set of plans such as we make for practical use sent them for more close examination in their several parts.



M

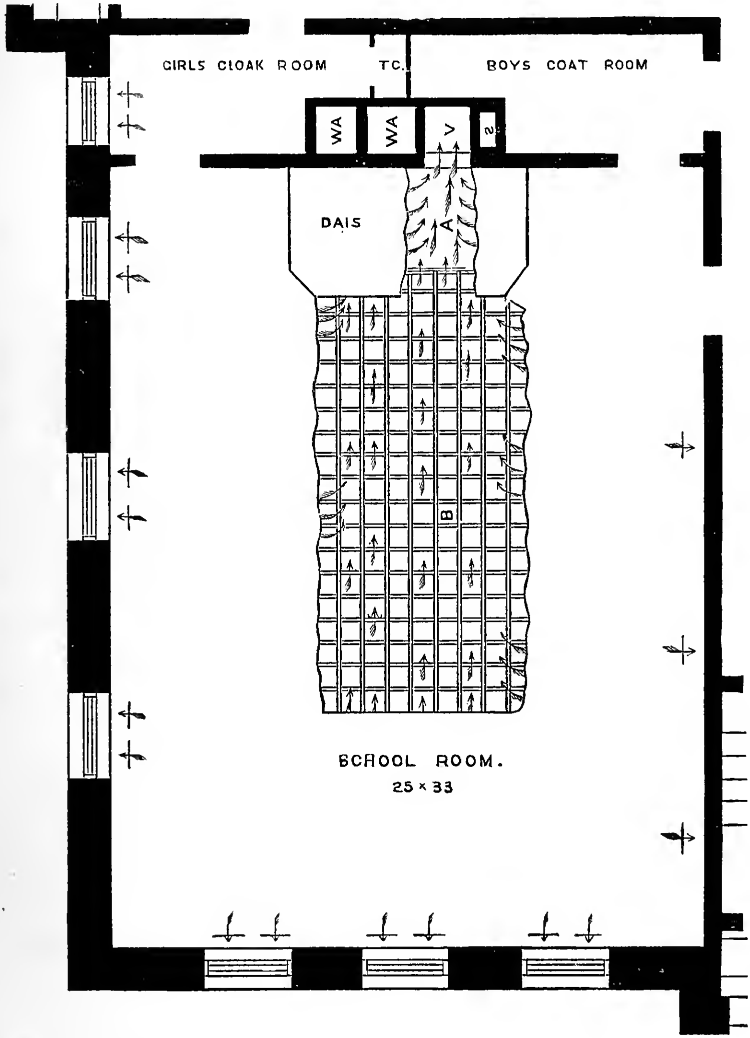
This cut represents a church of moderate size, say seating 200 to 250 people, which can be increased or decreased to meet the demands of any congregation. It has the pyramidal roof, a small bell tower, and, withal, is a neat and tasteful design, where style and taste can be appreciated. Plans will be furnished for a building of any size and capacity, in this style, or varied according to circumstances, to suit.

Cut N is a perspective of a church originally designed for a town in the southern part of this state. This cut represents an older style of building than some of those that have preceded it, but it has some excellent features, especially inside. One of them is its Sunday-school room in front of the main auditorium, to which it may be attached for the purpose of increased floor space. It has its social rooms over the Sunday-school rooms, such as kitchen, parlor, dressing rooms, etc.

N

This ends our series of miscellaneous designs, but we have still a great many others, and shall be making more from time to time in the usual routine of business. Persons wanting to build a fancy office building, or a banking house, in the city or country, will do well to call at our office, or open correspondence in regard to such.

RUTTAN VENTILATION IMPROVED.



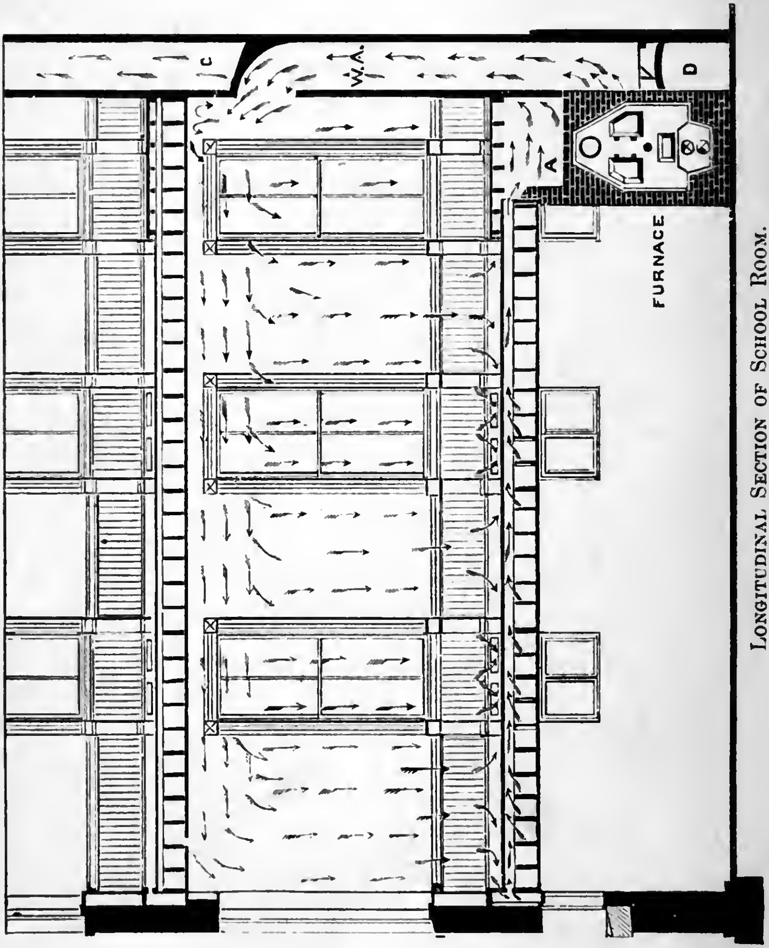
FLOOR FLAN.

REFERENCE LETTERS.

WA, Warm air flues.
V, Ventilation flue.
S, Smoke flue.

The arrows indicate where the foul air leaves the school room, and its direction after leaving it.

RUTTAN VENTILATION IMPROVED.



A, Foul air gathering chamber.
C, Foul air flue beyond the warm air flue.
D, Man hole.
W A, Warm air flue, showing connection with furnace, and inlet into school room.